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VOLUME 2

TASK 2: SEEKER SCENE EMULATOR DEVELOPMENT

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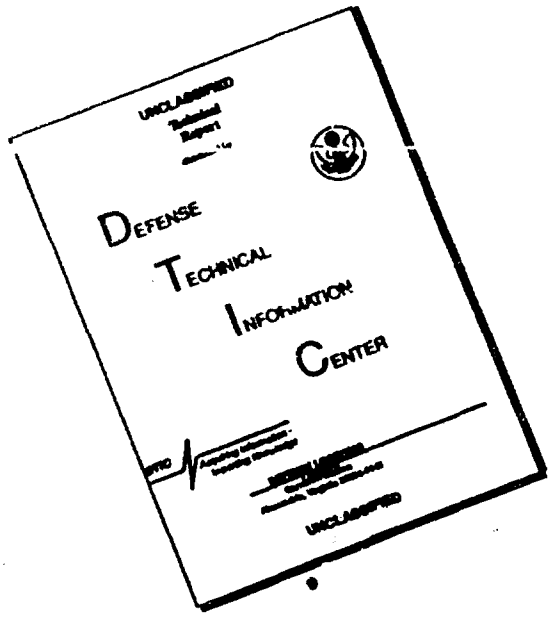

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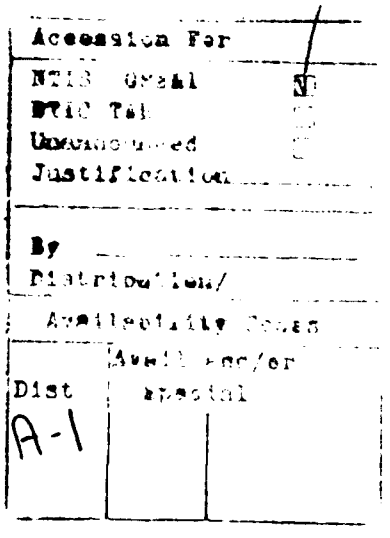

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TASK 2: SEEKER SCENE EMULATOR DEVELOPMENT

September 26, 1991

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1. Introduction

The Seeker Scene Emulator (SSE) is an important element of Georgia Tech's Digital Emulation Technology Laboratory (DETL). The Seeker Scene Emulator provides for real-time emulation of advanced Infrared Focal Plane Arrays, and thus, for real-time testing of closed-loop missile simulations (EXOSIM, for example) and real-time testing of Signal and Object Processing components.

Several programs described in this volume are not strictly SSE derived (Neural Network Signal Processing, for example), however, these projects are dependent upon the SSE for testing. For this reason, LATS interfacing and Neural Network Signal Processing are include in this volume.

1.1. Objectives

A first generation Seeker Scene Emulator has been developed and documented in previous annual reports. Current development centers around maximizing the usefulness of the SSE and improving operation. A major addition to the SSE is the GT-SPI, or SSE/Signal Processing Interface. This component interfaces the Seeker Scene Emulator to the Custom VLSI Signal and Object Processing Chipset developed by the Computer Engineering Laboratory at Georgia Tech. Several changes were made to the interconnection and programming of the SSE to accommodate this device. Because of these changes, an updated description of the operation of the SSE is presented here.

A planned enhancement to the Signal Processing Interface is gamma-injection circuitry. This addition will allow for the testing of gamma-circumvention techniques and/or hardware. The current design calls for this circuitry to operate as a modular signal conditioner to the existing interface.

The Computer Engineering Research Laboratory has been investigating the use of neural networks in the development of signal and object processing of focal plane array signals. One effort is being conducted by the Seeker Scene Emulator design group for hardware reasons to be discussed in a later section.

Portions of the Seeker Scene Emulator have, in the past, been used as a testbed for Signal Processing development. In a related effort, an Advanced Signal Processing Testbed is being constructed using processing elements similar to those in the Seeker Scene Emulator. This unit will enhance Georgia Tech's abilities in the development of VLSI Signal Processing devices by serving as a real-time or near real-time emulation of candidate algorithms and implementations.

An interface between a LATS signal processor and a CERL object processing sub-system is under development. This interface will provide LMSC with capabilities for conducting closed-loop testing.

1.2. Schedules and Milestones

The schedule for Seeker Scene Emulator development is shown in Figure 1. Major sub-headings in the schedule match sections of discussion in this document.

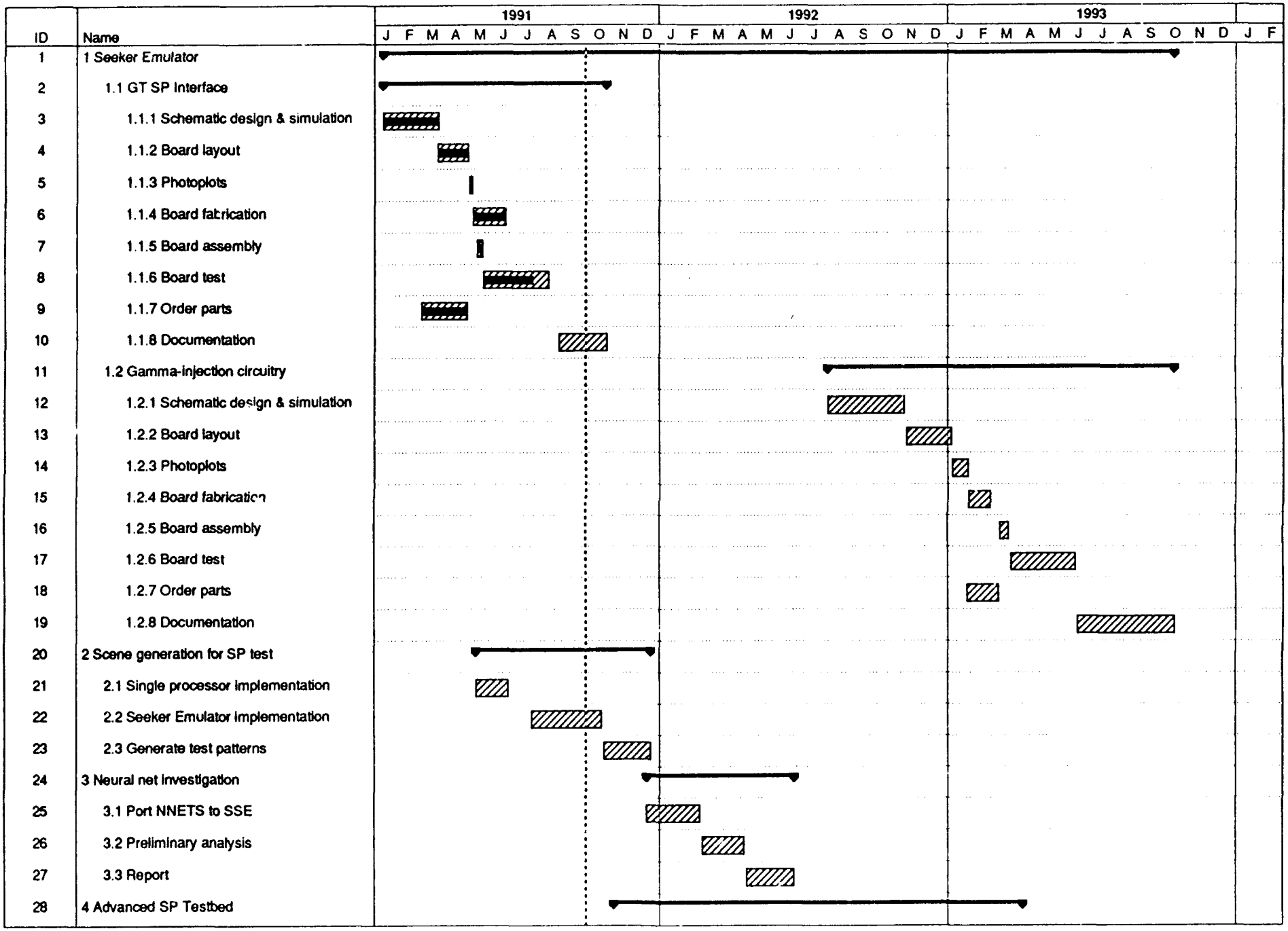

Figure Schedules and Milestones

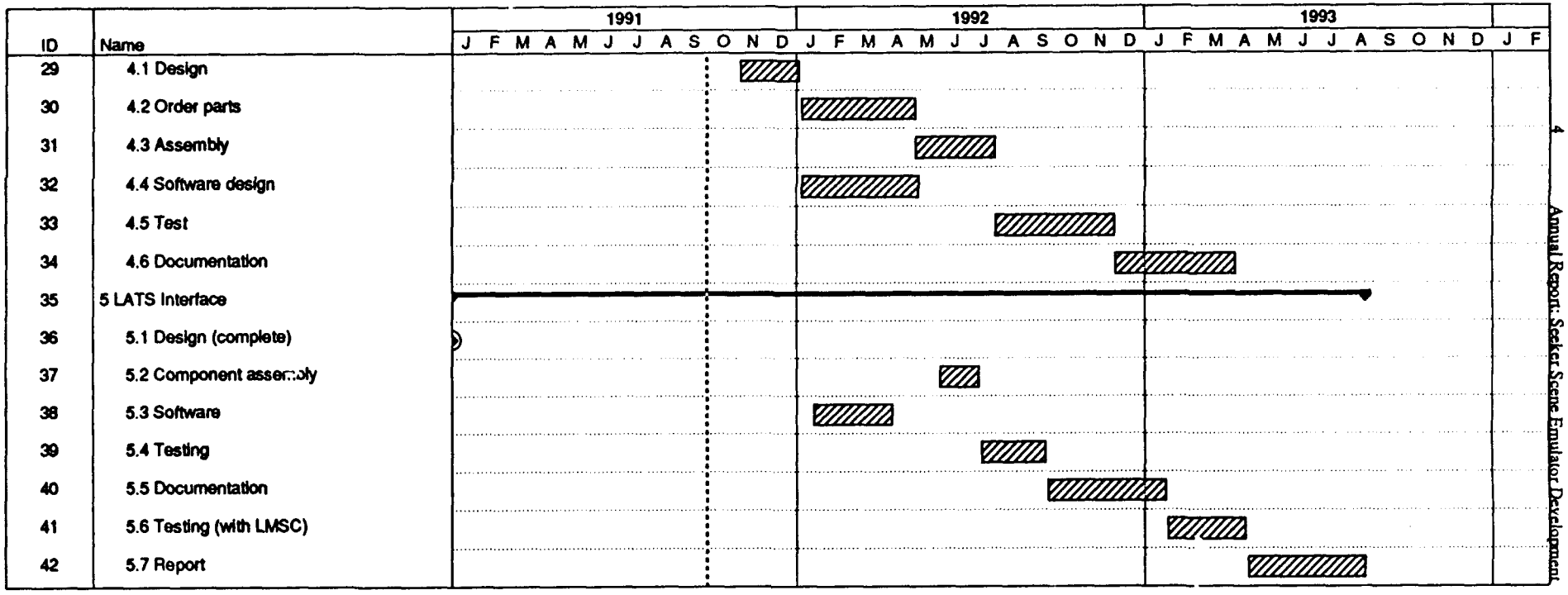

Figure 1: Schedules and Milestones

2. Seeker Scene Emulator

The Seeker Scene Emulator provides the Georgia Tech Digital Emulation Technology Laboratory with the capability for real-time testing of signal and object processing components. The SSE is capable of emulating infrared focal plane arrays with 128x128 detectors and, up to, 100 frame per second operation.

2.1. Description

The Seeker Scene Emulator has been thoroughly discussed in previous annual reports, so only a brief description will be given here. Updated processor interconnection and software listings are provided. A new component of the Seeker Scene Emulator, the GT-SPI SSE/Signal Processing Interface is presented in detail.

2.2. Hardware components

The whole of the Seeker Scene Emulator encompasses the processors and memory used in storing and manipulating the Seeker Scene data, the custom input/output interfaces, and the off-the-shelf host computers and displays. This can be summarized in the following list:

Main SSE

256 T800 Transputers, 2 Mbytes RAM each
3 T800 Transputer-based Video Frame Store, 2 MBytes RAM each
1 Analog Graphics Display board

Input/Output Interfaces

GT-XBI	Transputer to Georgia Tech PFP Crossbar Interface
GT-SPI	SSE / Signal Processing Interface
IMS B418	SCSI Transputer Module, Exabyte 4Gbyte, 8mm tape drive

Host Computer, Displays

80286-based Industry Standard Architecture Personal Computer
Enhanced Graphics Adapter and Monitor for PC,
High-resolution Multi-sync monitor for display of SSE graphics

As a great deal of the Seeker Scene Emulator hardware and software components have previously been published, the following sections will only deal with updating the status of the primary SSE hardware (the processors and their interconnection) and updated software. Additionally, a full discussion of the GT-SPI hardware and software is given.

2.2.1. Seeker Scene Emulator

The Seeker Scene Emulator is primarily composed of 256 Inmos T800 Transputers. The T800 Transputer is a fast 32-bit microprocessor with on-chip floating-point (1.5 MFLOPS) and optimized for parallel processing operation. Each T800 has 4 kbytes of internal high-speed static

RAM and four bi-directional, 20 Mbits/second communication links. In the Seeker Scene Emulator, the majority of the processors are each configured with 2 MBytes of external RAM.

The communication links largely define the operation of a network of Transputers and the interconnection of the processors making up the Seeker Scene Emulator are shown in Figures 2a and 2b.

The bulk of the processors in the SSE handle the storage of the Target data frames. As many processors as desired can be connected into the Target data processor array, and this directly constrains the number of frames allowed per simulation. Frequently, the SSE is operated with 128 processors generating the target image (approximately 230 frames) with the spare processors allocated to Signal Processing emulation, communication routing, etc.

One new component in the SSE is a SCSI Interface module. This module is a commercially available Transputer-based SCSI controller. This module will be used to read scene data from an Exabyte 8mm tape drive. The storage requirements for the SSE data are extremely large with each frame consuming 1 MByte. We have used the Exabyte units, which can hold 4 GBytes per cartridge, as a repository for the data, but an intermediate computer has always been used for control. The new interface should provide direct, high-speed access to the tape data.

Seeker Emulator Interconnections

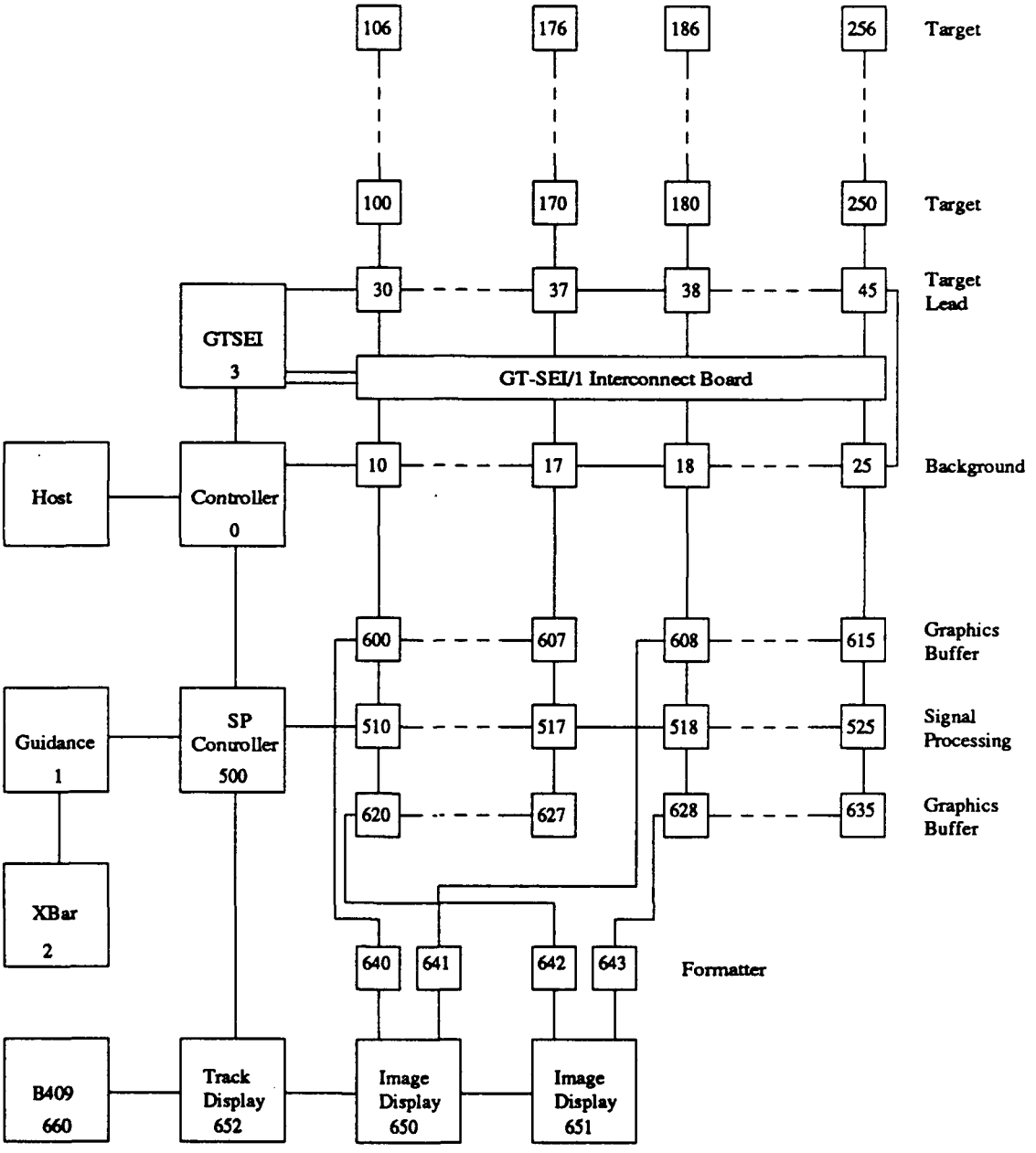

Figure 2a: Processor Identification

Seeker Emulator Interconnections

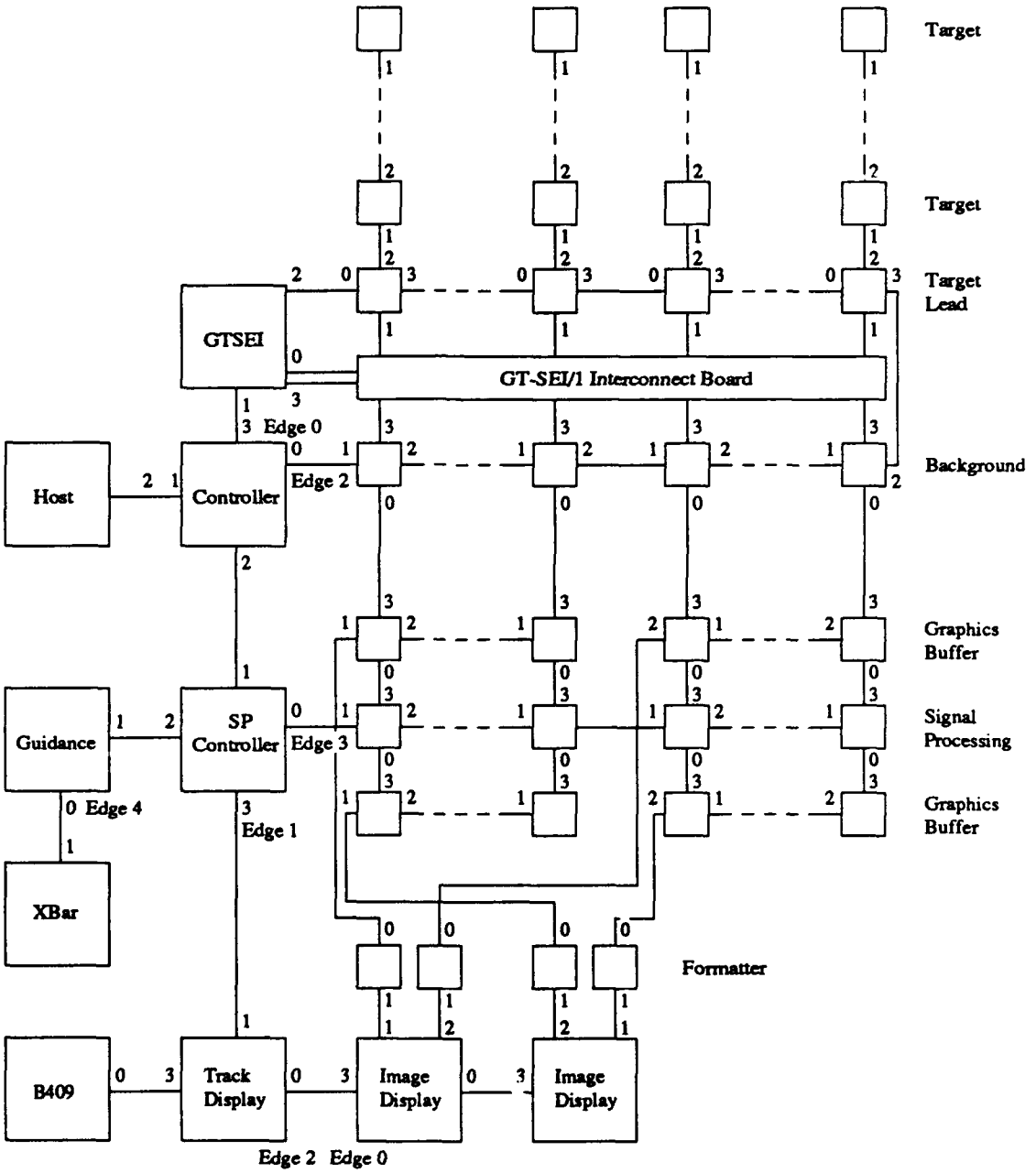

Figure 2b: Link Identification

2.2.2. SSE/SP Interface

The Seeker Scene Emulator is designed for real-time component testing of signal and object processing. Therefore, one requirement for the SSE would be the inclusion of some interface to an external signal processing sub-system. The GT-SPI SSE/SP Interface was built for that purpose.

2.2.2.1. Description

The GT-SPI takes as its basic input a stream of data representing an emulated focal plane array. The Seeker Scene Emulator, as mentioned above, uses the Inmos Transputer as the basis for its architecture and naturally performs communications through any number of Inmos standard links. Therefore, the GT-SPI was built with a Transputer as the controlling processor and it can communicate through up to four 20 Mbit/second links. The output from the GT-SPI consists of a set of clocks, strobes, and 16-bit pixel data.

The schematics for the interface are shown in Figures 3a-3c.

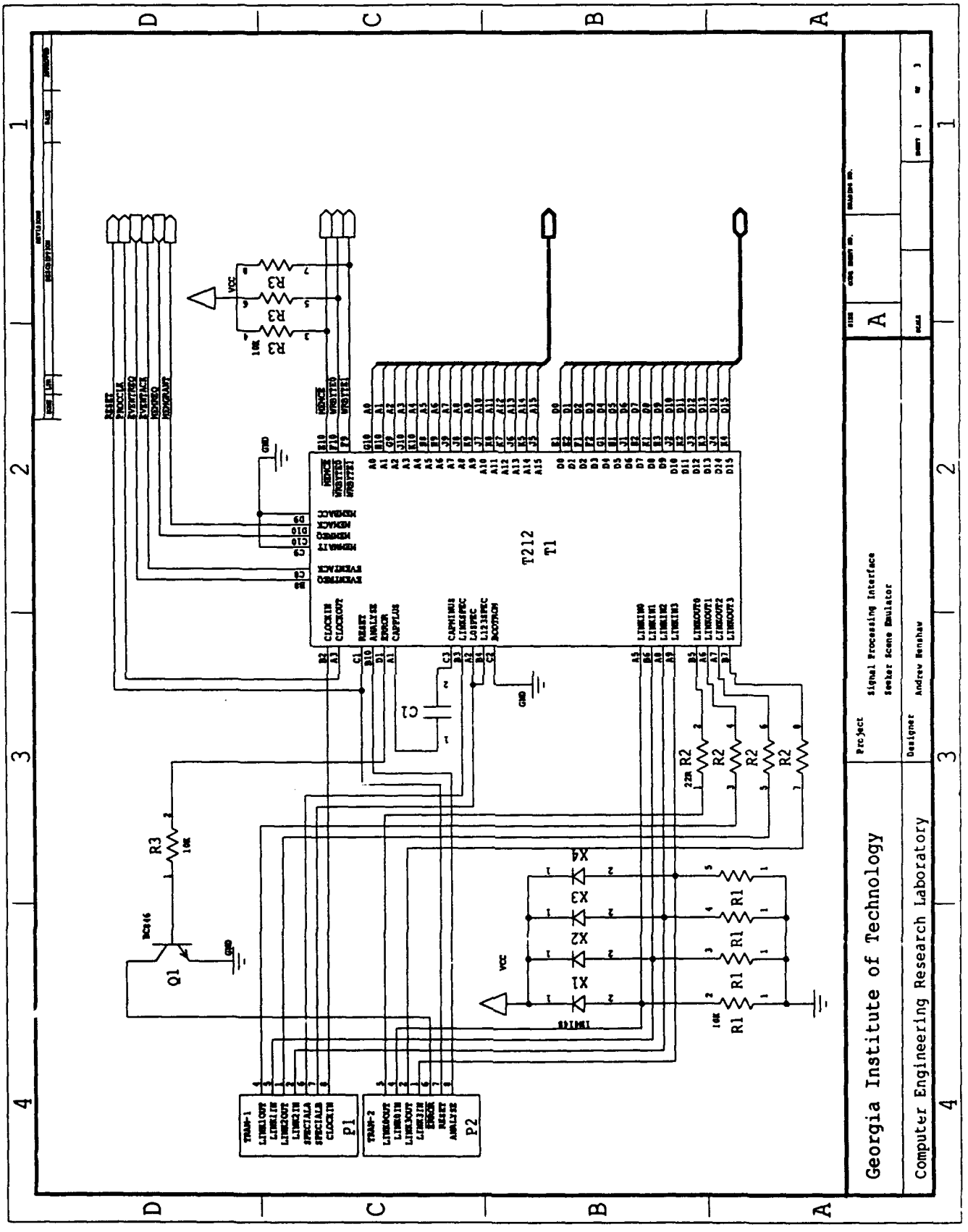

Figure 3a: GT-SPI Schematic

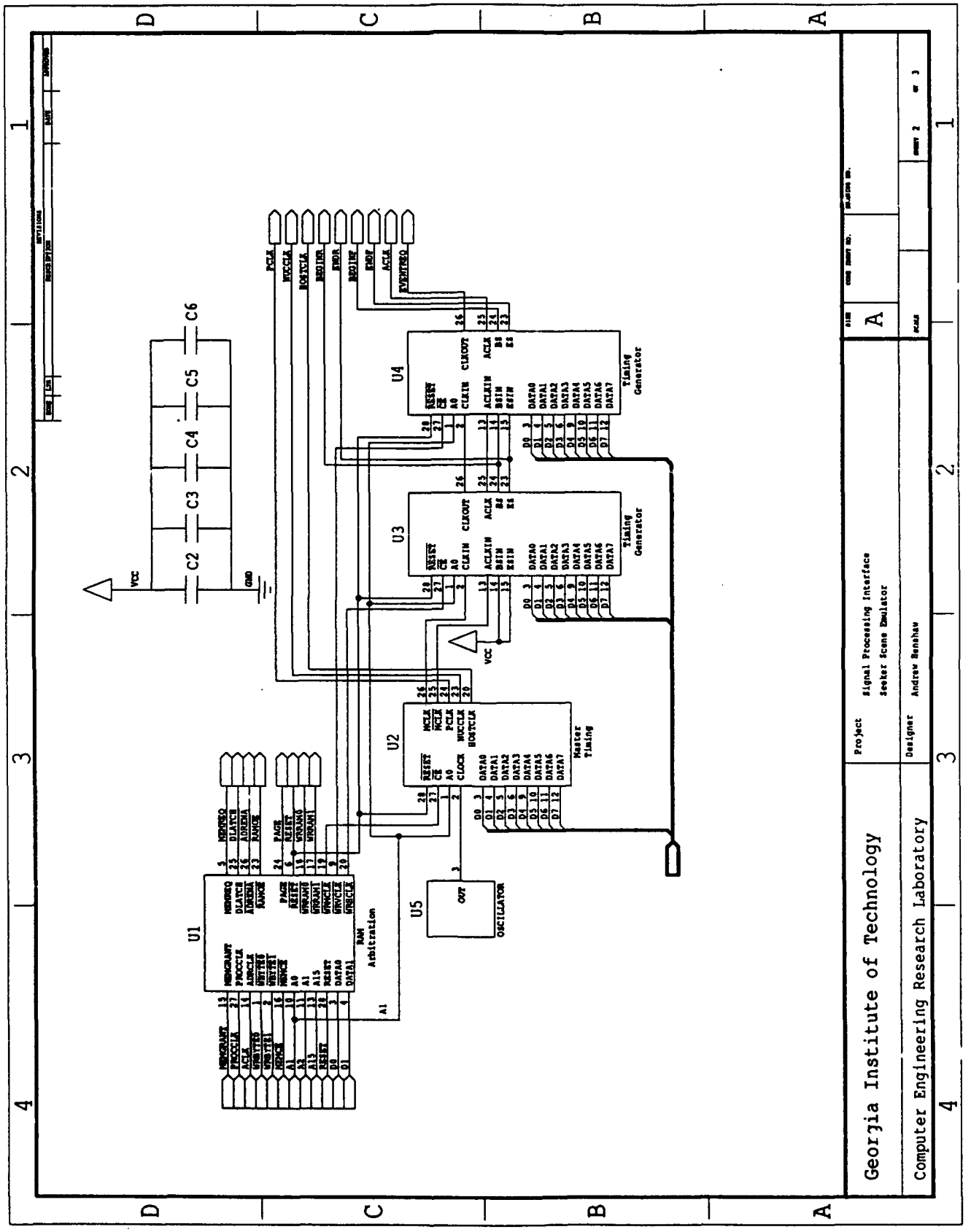

Figure 3b: GT-SPI Schematic (continued)

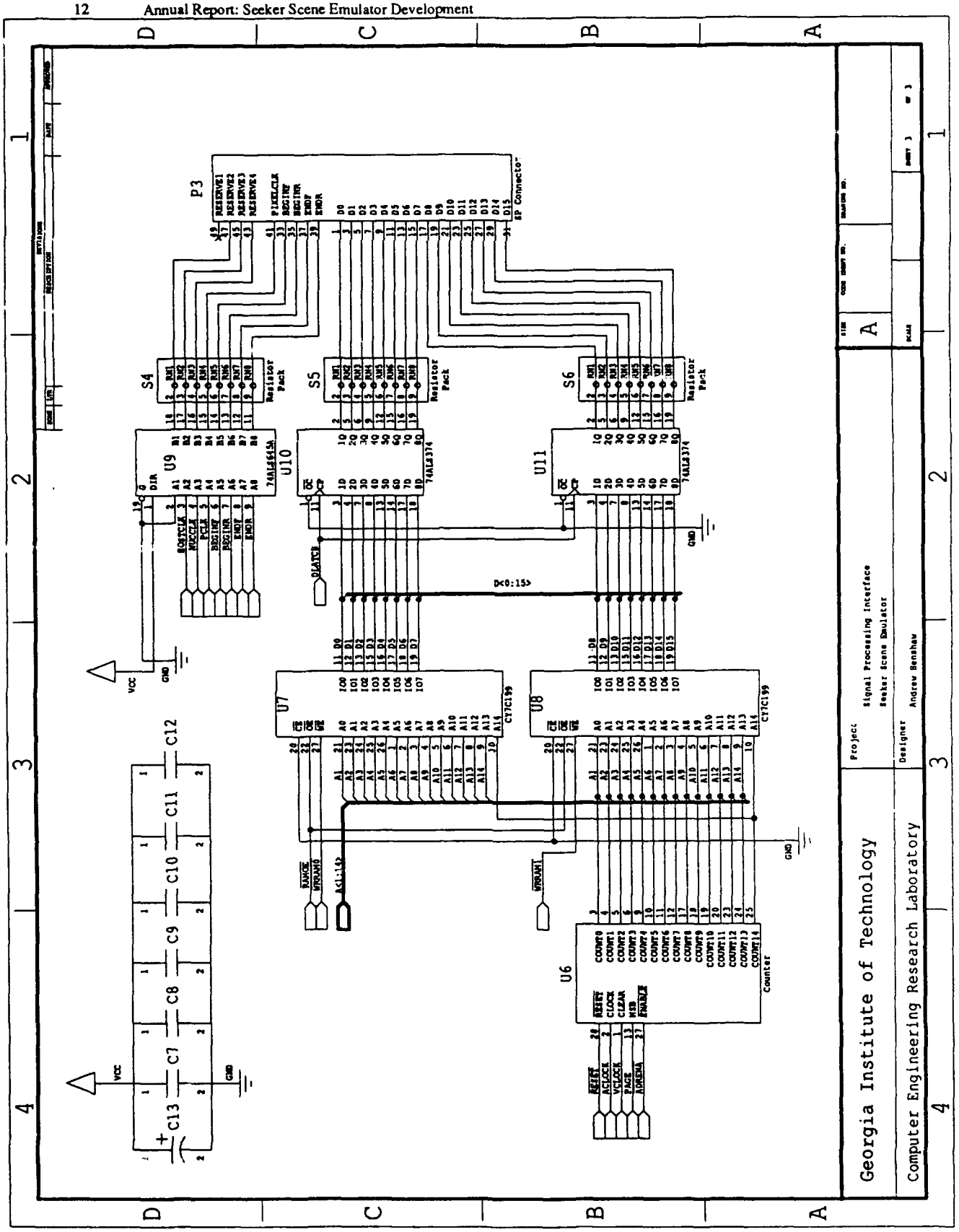

Figure 3c: GT-SPI Schematic (continued)

2.2.2.2. Hardware

The GT-SPI is primarily controlled by a single processor with an attached frame store. This store is shared with direct memory access readout electronics that presents the pixel data to an output bus at regular intervals. The timing for these intervals is generated by three custom-programmed Erasable Programmable Logic Devices (EPLDs). These EPLDs are the Master Clock Generator, the Vertical Clock Generator, and the Horizontal Clock Generator. Arbitration between frame store accesses is controlled by another custom EPLD, the Memory Access Controller. Finally, a fifth EPLD, the Address Generator, is used to generate 15-bit memory addresses.

2.2.2.2.1. Processor

The controlling processor for the GT-SPI is an Inmos T225 16-bit Transputer. This processor was chosen for its compatibility with the Transputer-based Seeker Scene Emulator, the 16-bit word access, and its fast memory interface. The T225 has 4 Inmos-standard communication links operating at 20 Mbits/second. External memory access cycle time is 100 ns for a bandwidth of 20 Mbytes/second. The T225 has 4 Kbytes of fast (50 ns) internal RAM and can address 60 or 64Kbytes of external memory, depending upon configuration.

2.2.2.2.2. Memory Access Controller

The Memory Access Controller is an Altera MAXPlus EPM5032 EPLD programmed as shown in Listing 2. The primary responsibility of the Memory Access Controller is to arbitrate access to the memory used for storing the FPA image data. The image data RAM is a 35 ns, 32Kx16 memory consisting of two Cypress CY7C192 chips. The 32Kx16 address space permits the storing of two individual frames of 128x128x16 bit data.

As the address space of the T225 does not directly support 64Kbytes of external memory along with 4 Kbytes of internal memory, an addressable register controls access two either of the two banks of 16Kx16 RAM for both the processor and the readout electronics. These bits can be set individually, so that the processor could be writing into one bank while the readout was accessing the other bank.

Although the GT-SPI is intended for use with emulations of 128x128x16 bit Focal Plane Arrays, smaller sizes can be tested (as will be discussed in the Timing chips section). Additionally, provision has been made to allow for readout of the entire 32Kx16 data space for arrays up to 181x181 or 256x128.

In operation, the T225 will write to or read from external memory until a *Memory Request* signal is sent from the Memory Access Controller. This signal is generated once per pixel output and will indicate that the T225 must relinquish control of the external memory bus as soon as possible. The T225 will tri-state its data and address signal lines and issue a *Memory Grant* signal. A T225 running at 20MHz is guaranteed to grant direct memory access with 100 ns. Once the *Memory Grant* has been received, the Memory Access Controller enables the Address Generator (discussed below) and latches the output data into the 74ALS245 buffers. At this

point, the *Memory Request* is terminated and control passes back to the processor. Even while running at the maximum specified output rate (600 ns per pixel), the processor will still be able to access external memory twice per pixel cycle.

The Memory Access Controller chip contains two processor-accessible control registers. These registers and their address offsets are given below in Table 1. Additionally, this EPLD decodes address enable lines for all of the other addressable chips in the system. These addresses are also provided.

Table 1: GT-SPI Memory Map

Name	Address Offset	Bit designation
Ram Control	6	0 - Page of RAM for processor access 1 - Page of RAM for DMA access
System Control	7	0 - Reset
Master Clock Chip Enable	0	---
Horizontal Clock Chip Enable	2	---
Vertical Clock Chip Enable	4	---
RAM Chip Enable	32768	---

Listing 1: Memory Access Controller

```
%*****************************************
*                                       *
            Ram Control Logic
*                                       *
*****************************************%
TITLE "Ram Logic";
DESIGN IS "LOGIC"
BEGIN
    DEVICE IS "EPM5032D"
    BEGIN
        Reset       @  28 : INPUT  ;
        ProcClock   @  27 : INPUT  ;
        /MemCE      @  16 : INPUT  ;
        /WByte0     @   1 : INPUT  ;
        /WByte1     @   2 : INPUT  ;
        MemGrant    @  15 : INPUT  ;
        A0          @  10 : INPUT  ;
        A1          @  11 : INPUT  ;
        A2          @  12 : INPUT  ;
        A15         @  13 : INPUT  ;
        Data0       @   3 : INPUT  ;
        Data1       @   4 : INPUT  ;
        aclk        @  14 : INPUT  ;
        /AdrEnable  @  26 : OUTPUT ;
        DataLatch   @  25 : OUTPUT ;
        MemReq      @   5 : OUTPUT ;
        Page        @  24 : OUTPUT ;
        /RamOE      @  23 : OUTPUT ;
        /reset      @   6 : OUTPUT ;
        /WrHclock   @  20 : OUTPUT ;
        /WrMclock   @  19 : OUTPUT ;
        /WrRam0     @  18 : OUTPUT ;
        /WrRam1     @  17 : OUTPUT ;
        /WrVclock   @   9 : OUTPUT ;
    END;
END;

SUBDESIGN Logic
(
  MemGrant    : INPUT ;
  ProcClock   : INPUT ;
  aclk    : INPUT ;
  /WByte0     : INPUT ;
  /WByte1     : INPUT ;
  /MemCE      : INPUT ;
  A2,A1,A0,
  A15         : INPUT ;
  Reset       : INPUT ;
  Data[1..0]  : INPUT ;

  MemReq      : OUTPUT ;
  DataLatch   : OUTPUT ;
  /AdrEnable  : OUTPUT ;
  /RamOE      : OUTPUT ;
  /WrMclock   : OUTPUT ;
  /WrHclock   : OUTPUT ;
  /WrVclock   : OUTPUT ;
  /WrRam0     : OUTPUT ;
  /WrRam1     : OUTPUT ;
  Page        : OUTPUT ;
  /reset      : OUTPUT ;
)
VARIABLE
  enable,
```

```
  activate   : TFF ;
  mrff       : DFF ;
  /ram,
  /mclock,
  /hclock,
  /vclock,
  /regs      : NODE ;
  /WrRegs    : NODE ;
  AdrEnable  : NODE ;
  /control   : NODE ;
  /WrControl: NODE ;
  RamA14ff   : DFF  ;
  CntA14ff   : DFF  ;
  resetff    : DFF  ;
  /WByte0int : TFF ;
  /WBytelint : TFF ;
BEGIN
  /mclock    = NOT (A15 AND !A2 AND !A1) ;
  /hclock    = NOT (A15 AND !A2 AND  A1) ;
  /vclock    = NOT (A15 AND  A2 AND !A1) ;

  /regs      = NOT (A15 AND  A2 AND  A1 AND !A0) ;
  /control   = NOT (A15 AND  A2 AND  A1 AND  A0) ;
  /ram       = A15 ;
  /WrMclock  = /mclock  OR /WByte0int OR /MemCE ;
  /WrHclock  = /hclock  OR /WByte0int OR /MemCE ;
  /WrVclock  = /vclock  OR /WByte0int OR /MemCE ;
  /WrRegs    = /regs    OR /WByte0int OR /MemCE ;
  /WrControl = /control OR /WByte0int OR /MemCE ;
  /WrRam0    = /ram     OR /WByte0int OR /MemCE ;
  /WrRam1    = /ram     OR /WBytelint OR /MemCE ;

% RamA14ff holds the high address bit used by the processor %
% when selecting RAM -- enables the T212 to bank switch     %
% 64K into 32K                                              %
% CntA14ff holds the corresponding bit for the read-out     %
% circuitry.  This allows for frame buffering               %

  RamA14ff.clk  = /WrRegs ;
  RamA14ff      = Data0 ;
  RamA14ff.clrn = !Reset ;

  CntA14ff.clk  = /WrRegs ;
  CntA14ff      = Data1 ;
  CntA14ff.clrn = !Reset ;

  resetff.clk   = /WrControl ;
  resetff.clrn  = !Reset ;
  resetff       = Data0 ;
  /reset        = resetff ;

  activate.prn = MemGrant   ;
  activate.t   = enable.q   ;
  activate.clk = ProcClock  ;

  enable.t     = VCC ;
  enable.prn   = MemGrant   ;
  enable.clk   = DataLatch  ;

  mrff.d       = VCC ;
  mrff.clk     = aclk   ;
  mrff.clrn    = DataLatch  ;

  DataLatch    = activate.q ;
  MemReq       = mrff.q ;
  AdrEnable    = NOT MCELL(DataLatch) ;
  /AdrEnable   = NOT AdrEnable ;
```

```
  /WByte0int.t = VCC ;
  /WByte0int.prn = !/WByte0 ;
  /WByte0int.clk = !ProcClock ;

  /WByte1int.t = VCC ;
  /WByte1int.prn = !/WByte1 ;
  /WByte1int.clk = !ProcClock ;

  /RamCE = NOT ((/WByte0 AND /WByte1) OR /MemCE) ;
  Page = (RamA14ff AND /AdrEnable) OR (CntA14ff AND AdrEnable) ;

END ;
```

2.2.2.2.3. Master Clock Generator

The Master Clock generator is a programmable clock divider for generating frequencies of 2 to 255 times slower than a reference clock (typically a 10 MHz oscillator). This clock is provided to the Signal processing boards as the NUC Clock and is divided by 4 to yield the Pixel Clock.

The Master Clock Generator is contained in one EPM5032 programming logic shown in Listing 2. It has one programmable 8-bit register to hold the divider parameter and a one-bit register to hold a clock enable gate. When this gate is programmed LOW then the master clock is disabled, a HIGH value enables the clock.

The Divider Register is accessed at the base address of the Master Clock Chip Enable (see above) while the Clock Gate Register is at the next higher address.

Listing 2: Master Clock Generator

```
%*******************************************
*                                          *
*            Master Timing Generator       *
*                                          *
*******************************************%
TITLE "Master Timing Generator";

DESIGN IS "master"
BEGIN
  DEVICE IS "EPM5032"
  BEGIN
      /reset   @  28 : INPUT  ;
      /ce      @  27 : INPUT  ;
      a0       @  1  : INPUT  ;
      clock    @  2  : INPUT  ;
      data0    @  3  : INPUT  ;
      data1    @  4  : INPUT  ;
      data2    @  5  : INPUT  ;
      data3    @  6  : INPUT  ;
      data4    @  9  : INPUT  ;
      data5    @  10 : INPUT  ;
      data6    @  11 : INPUT  ;
      data7    @  12 : INPUT  ;
      mclk     @  26 : OUTPUT ;
      /mclk    @  25 : OUTPUT ;
      pclk     @  24 : OUTPUT ;
      nucclk   @  23 : OUTPUT ;
      hostclk  @  20 : OUTPUT ;
  END;
END;


SUBDESIGN master
(
  /reset,
  clock,
  /ce,
  a0,
  data[7..0] : INPUT;

  mclk, /mclk, pclk,
  nucclk, hostclk  : OUTPUT ;
)
VARIABLE
  divide[7..0]  : DFF ;
  count[7..0]   : DFF ;
  mclk_ff       : DFF ;
  gate          : DFF ;
  gateSync      : DFF ;
  /select[1..0] : NODE ;
  tempclk1      : TFF ;
  tempclk2      : TFF ;
  BEGIN
  /select[0]    = a0 ;
  /select[1]    = !a0  ;
  divide[]   = data[] ;
  gate       = data[0] ;

  divide[].clk   = /ce OR /select[0] ;
  gate.clk       = /ce OR /select[1] ;

  count[].clrn = %gate    AND % /reset    ;
  mclk_ff.clrn = %gate    AND % /reset    ;
  count[].clk = clock;
```

```
  mclk_ff.clk = clock ;
  IF (count[] == 0)  THEN
     count[] = divide[] ;
     mclk_ff = NOT mclk_ff ;
  ELSE
     count[] = count[] - 1 ;
     mclk_ff = mclk_ff ;
  END IF ;
  hostclk = clock ;
  nucclk  = mclk_ff ;
  tempclk1.clk = mclk_ff ;
  tempclk1.t   = VCC ;
  tempclk2.clk = tempclk1 ;
  tempclk2.t   = VCC ;
%  mclk  = tempclk2  ; %
%  /mclk = !tempclk2 ; %
  pclk  = mcell (mcell (mcell ( mcell (!tempclk2) ) ) );
  gateSync.clk = pclk ;
  gateSync     = gate ;
  mclk   = tempClk2 AND gateSync ;
  /mclk  = !(tempClk2 AND gateSync) ;
END ;
```

2.2.2.2.4. Horizontal and Vertical Clock Generators

The Horizontal and Vertical Clock Generators are, conceptually, very similar and will be discussed together. Except for some minor modifications, the programming of the two chips is nearly identical (see Listings 3 and 4) and each chip is a EPM5032.

To provide as much flexibility as possible, the design of these two chips reflects the design of conventional video circuitry. The horizontal timing chip controls the number of pixels per row of the emulated Focal Plane Array, while the vertical timing chip controls the number of rows per frame. Additionally, both chips can be programmed to provide a dead time between active rows or frames. This dead time would correspond to the horizontal and vertical retrace and blanking intervals of a normal video interface. For example, a 128x128 pixel FPA could be emulated by programming the *active registers* of the horizontal and vertical chips 128 each. Then, a small blanking interval of two pixel clocks could be inserted between each readout row by programming the *blanking register* to two.

Both the *active register* and the *blanking register* are 8 bits wide and, thus, timing for FPAs up to 255 active and blanked pixels per row, and 255 active and blanked rows per frame can be emulated (although memory constraints would limit the total number of active pixels). One use of the blanking periods is to reduce the total frame rate. For example, if the base frame rate with no blanking intervals is 100 frames per second, an addition of horizontal or blanking periods equal to the number of pixels per row or rows per frame would reduce the frame rate to 50 frames per second.

In the operation of the GT-SPI, the vertical clock chip takes it input clock from the output of the horizontal clock chip which cycles once per row. The horizontal clock chip uses the pixel clock as its own clock. Both outputs are used to derive the signal which is fed to the Address Generator chip (see below).

The programming address for the *active register* is the base address of each respective chip, while the address for each *blanking register* is at base address plus one. One point to note is that both registers implicitly add one to the value stored. Therefore, the smallest active or blanking interval would be one clock cycle.

Listing 3: Horizontal Clock Generator

```
%*****************************************
*                                        *
*            Timing Generator            *
*                                        *
*****************************************%
TITLE "Timing Generator";
DESIGN IS "HCLOCK"
BEGIN
    DEVICE IS "EPM5032D"
    BEGIN
        /reset   @  28 : INPUT  ;
        /ce      @  27 : INPUT  ;
        a0       @   1 : INPUT  ;
        clkIn    @   2 : INPUT  ;
        aClkIn   @  13 : INPUT  ;
        bsIn     @  14 : INPUT  ;
        esIn     @  15 : INPUT  ;
        blankIn  @  17 : INPUT  ;
        data0    @   3 : INPUT  ;
        data1    @   4 : INPUT  ;
        data2    @   5 : INPUT  ;
        data3    @   6 : INPUT  ;
        data4    @   9 : INPUT  ;
        data5    @  10 : INPUT  ;
        data6    @  11 : INPUT  ;
        data7    @  12 : INPUT  ;
        aClk     @  25 : OUTPUT ;
        bs       @  24 : OUTPUT ;
        clkOut   @  26 : OUTPUT ;
        es       @  23 : OUTPUT ;
    END;
END;

SUBDESIGN hclock
(
  /reset,
  /ce,
  clkIn,
  blankIn,
  aClkIn,
  a0,
  bsIn, esIn,
  data[7..0] : INPUT;

  clkOut,
  aClk,
  bs,
  es        : OUTPUT ;
)

VARIABLE
  active[7..0] : DFF ;
  blanking[7..0] : DFF ;
  count[7..0] : DFF  ;
  clkOut_ff  : DFF ;
  /select[1..0] : NODE ;
  /reset_sync : DFF ;

BEGIN
  /select[0]    = a0  ;
  /select[1]    = !a0 ;
  active[]   = data[] ;
  blanking[] = data[] ;
```

```
  active[].clk   = /ce OR /select[0] ;
  blanking[].clk = /ce OR /select[1] ;

  count[].clk = clkIn;
  clkOut_ff.clk = clkIn ;
  /reset_sync.clk = clkIn;
  /reset_sync.clrn = /reset ;
  /reset_sync = /reset ;

%  IF NOT (/reset) THEN %
%    count[] = blanking[] ; %
%    clkOut_ff = VCC ;%
%    bs = GND; %
%    es = GND; %
  clkOut_ff.prn = /reset_sync ;
  count[].clrn  = /reset_sync ;

  IF (count[] == 0) & (clkOut_ff == GND) THEN
     count[] = blanking[] ;
     clkOut_ff = VCC ;
%     es = esIn  AND  !blankIn ;%
     es = GND ;
     bs = GND ;
  ELSIF (count[] == 1) & (clkOut_ff == GND) THEN
     count[] = count[] - 1 ;
     clkOut_ff = clkOut_ff ;
     es = esIn  AND  !blankIn ;
     bs = GND ;
  ELSIF (count[] == 0) & (clkOut_ff == VCC) THEN
     count[] = active[] ;
     clkOut_ff = GND ;
     bs = bsIn  &  !blankIn  & /reset_sync;
     es = GND ;
  ELSE
     count[] = count[] - 1 ;
     clkOut_ff = clkOut_ff ;
     bs = GND;
     es = GND ;
  END IF ;
  clkOut = clkOut_ff ;
  aClk   = aClkIn AND !clkOut;
END ;
```

Listing 4: Vertical Clock Generator

```
%*****************************************
*                                        *
*            Timing Generator
*                                        *
*****************************************%
TITLE "Timing Generator";
DESIGN IS "VCLOCK"
BEGIN
    DEVICE IS "EPM5032D"
    BEGIN
        /reset   @  28 : INPUT  ;
        /ce      @  27 : INPUT  ;
        a0       @   1 : INPUT  ;
        clkIn    @   2 : INPUT  ;
        aClkIn   @  13 : INPUT  ;
        bsIn     @  14 : INPUT  ;
        esIn     @  15 : INPUT  ;
        data0    @   3 : INPUT  ;
        data1    @   4 : INPUT  ;
        data2    @   5 : INPUT  ;
        data3    @   6 : INPUT  ;
        data4    @   9 : INPUT  ;
        data5    @  10 : INPUT  ;
        data6    @  11 : INPUT  ;
        data7    @  12 : INPUT  ;
        aClk     @  25 : OUTPUT ;
        bs       @  24 : OUTPUT ;
        clkOut   @  26 : OUTPUT ;
        es       @  23 : OUTPUT ;
        blankOut @  17 : OUTPUT ;
    END;
END;

SUBDESIGN vclock
(
  /reset,
  /ce,
  clkIn,
  aClkIn,
  a0,
  bsIn, esIn,
  data[7..0] : INPUT;

  clkOut,
  blankOut,
  aClk,
  bs,
  es        : OUTPUT ;
)

VARIABLE
  active[7..0] : DFF ;
  blanking[7..0] : DFF ;
  count[7..0] : DFF  ;
  clkOut_ff  : DFF ;
  /select[1..0] : NODE ;
  start : DFF ;

BEGIN
  /select[0]    = a0  ;
  /select[1]    = !a0 ;
  active[]   = data[] ;
  blanking[] = data[] ;
```

```
  active[].clk   = /ce OR /select[0] ;
  blanking[].clk = /ce OR /select[1] ;

  count[].clk   = clkIn;
  clkOut_ff.clk = clkIn ;
  start.clk     = clkIn ;

%  IF NOT (/reset) THEN     %
%    count[] = blanking[] ; %
%    clkOut_ff = VCC ; %
%    bs = GND;        %
%    es = GND;        %
%    blankOut = VCC ;%
%    start = GND ;    %

  count[].clrn = /reset ;
  clkOut_ff.prn = /reset ;
  start.clrn = /reset ;

  IF (count[] == 0) & (clkOut_ff == GND) THEN
     count[] = blanking[] ;
     clkOut_ff = VCC ;
     es = esIn AND /reset;
     bs = GND ;
     blankOut = start OR !/reset;
  ELSIF (count[] == 0) & (clkOut_ff == VCC) THEN
     count[] = active[] ;
     clkOut_ff = GND ;
     bs = bsIn AND /reset;
     es = GND ;
     start = VCC ;
     blankOut = %GND OR % !/reset;
  ELSE
     count[] = count[] - 1 ;
     clkOut_ff = clkOut_ff ;
     bs = GND;
     es = GND ;
     blankOut = clkOut_ff OR !/reset;
  END IF ;
  clkOut = clkOut_ff ;

  aClk   = aClkIn AND !clkOut ;
END ;
```

2.2.2.2.5. Address Generator

The Address Generator chip is also programmed (Listing 5) into an EPM5032, demonstrating the flexibility of this EPLD. This EPLD was specified for all of these parts for the principal reason of requiring a small inventory of separate devices for maintenance and development. However, the EPM5032 is so flexible, that almost all of the functions shown here could not have been done with lesser EPLDs.

The Address Generator uses the input clock to drive a simple counter circuit that continually increments until the counter is reset by the clear or /reset inputs or the counter wraps around. The counter is a 15-bit register and can, therefore, generate addresses for the entire 32 kwords of memory. The most significant bit of the output address is combinatorially derived from the most significant bit of the counter register and the *msb* signal controlled by the MemoryControl Chip described above. This signal reflects the status of the page access control bits for the processor and the readout circuitry.

Listing 5: Address Generator

```
%*******************************************
*                                          *
          Address Generator
*                                          *
*******************************************%
TITLE "Address Generator";

DESIGN IS "COUNTER"
BEGIN
    DEVICE IS "EPM5032D"
    BEGIN
        /reset   @  28 : INPUT  ;
        /enable  @  27 : INPUT  ;
        clear    @  1  : INPUT  ;
        clock    @  2  : INPUT  ;
        msb      @  13 : INPUT  ;
        q0       @   3 : OUTPUT ;
        q1       @   4 : OUTPUT ;
        q2       @   5 : OUTPUT ;
        q3       @   6 : OUTPUT ;
        q4       @   9 : OUTPUT ;
        q5       @  10 : OUTPUT ;
        q6       @  11 : OUTPUT ;
        q7       @  12 : OUTPUT ;
        q8       @  17 : OUTPUT ;
        q9       @  18 : OUTPUT ;
        q10      @  19 : OUTPUT ;
        q11      @  20 : OUTPUT ;
        q12      @  23 : OUTPUT ;
        q13      @  24 : OUTPUT ;
        q14      @  25 : OUTPUT ;
    END;
END;

SUBDESIGN Counter
(
  /reset       : INPUT ;
  clock        : INPUT ;
  clear        : INPUT ;
  msb          : INPUT ;
  /enable      : INPUT ;
  q[14..0]     : OUTPUT ;
)
VARIABLE
  count[14..0] : DFF  ;
  buffer[13..0]: TRI  ;

BEGIN
  q[13..0]          = buffer[13..0] ;
  buffer[13..0]     = count[13..0] ;
  buffer[13..0].oe = NOT /enable ;
  q[14]         = (NOT(/enable) AND count[14]) OR msb ;
  count[].prn = (NOT clear) AND /reset ;
  count[].clk  = clock;
  count[] = count[] + 1 ;
END ;
```

2.2.2.3. Programming

A simple program to test the functionality of the GT-SPI interface is shown in Listing 6. In operation, the GT-SPI processor initializes the control registers and clears the frame store. Then it enters a loop waiting for commands from an external processor, which, in this case, is the host processor accepting input from a user.

This program allows a user to specify clock rates, reset the direct memory access circuitry, suspend the generation of the frame and row strobes, and to set individual or groups of pixel elements to specified values.

Appendix A lists the code for the operation of the entire Seeker Scene Emulator. The code supporting the GT-SPI is given in file "gtspi.occ" and shows the programming of the interface as an extension of the SSE. Initialization is done as discussed above and then the program goes into a tight loop where it simply receives and stores blocks of pixel data. In this version, the data arrives in parallel from two separate channels, but up to four could be used, if greater speed was required.

Listing 6: Example program for GT-SPI

```
PROC testerr (CHAN OF ANY test, from.host)
  --{{{  external memory and registers
  [16384]INT frame.buffer :
  PORT OF INT mclock.data :
  PORT OF INT mclock.control :
  PORT OF INT hclock.active :
  PORT OF INT hclock.blanking :
  PORT OF INT vclock.active :
  PORT OF INT vclock.blanking :
  PORT OF INT master.register :
  PORT OF INT control.register :
  CHAN OF ANY sync :
  --}}}
  --{{{  placements
  VAL base.address       IS #0800 :
  PLACE mclock.data      AT base.address :
  PLACE mclock.control   AT base.address + 1:
  PLACE hclock.active    AT base.address + 2 :
  PLACE hclock.blanking  AT base.address + 3 :
  PLACE vclock.active    AT base.address + 4 :
  PLACE vclock.blanking  AT base.address + 5 :
  PLACE master.register  AT base.address + 6 :
  PLACE control.register AT base.address + 7 :
  PLACE frame.buffer     AT #4000 :

  PLACE sync             AT 8 :
  --}}}

  --{{{  PROC testMem
  PROC testMem (VAL INT check)
    INT temp :
    SEQ
      master.register ! 0
      SEQ i = 0 FOR 16384
        frame.buffer[i] := i
      master.register ! 1
      SEQ i = 0 FOR 16384
        frame.buffer[i] := 16383 - i
      master.register ! 0
      --{{{
      SEQ i = 0 FOR 16384
        SEQ
          temp := frame.buffer[i]
          IF
            temp = i
              SKIP
            TRUE
              --{{{
              SEQ
                test ! (INT32 i)
                test ! (INT32 check)
                test ! (INT32 temp)
              --}}}
      --}}}
      master.register ! 1
      --{{{
      SEQ i = 0 FOR 16384
        SEQ
          temp := frame.buffer[i]
          IF
            temp = (16383 - i)
              SKIP
            TRUE
              --{{{
```

```
            SEQ
              test ! (INT32 i)
              test ! (INT32 check)
              test ! (INT32 temp)
            --}}}
    --}}}
:
--}}}
TIMER clock :
INT selection, scale, now :
INT numRows, numCols :
SEQ
  mclock.control ! 0      -- disable clock
  control.register ! 0    -- reset
  control.register ! 1    -- clear the reset condition
  --{{{  intialize
  SEQ
    numRows := 128
    numCols := 128
    hclock.active   ! numCols - 1
    hclock.blanking ! 1
    vclock.active   ! numRows - 1
    vclock.blanking ! 1
    mclock.data     ! 0
  --}}}

  SEQ i = 0 FOR 16384
    frame.buffer[i] := 0
  WHILE TRUE
    SEQ
      from.host ? selection ; scale
      --{{{  CASE selection
      CASE selection
        1
          mclock.data ! scale
        2
          SEQ
            hclock.active ! scale
            numCols := scale+1
        3
          hclock.blanking ! scale
        4
          SEQ
            vclock.active ! scale
            numRows := scale+1
        5
          vclock.blanking ! scale
        6
          SEQ i = 0 FOR 16384
            frame.buffer[i] := scale
        7
          INT row, col :
          SEQ
            from.host ? row; col
            frame.buffer[col + (row * numCols)] := scale
        8
          control.register ! scale   -- reset control is bit 0
        9
          SEQ
            mclock.control ! scale     -- clock enable  is bit 0
            IF
              scale = 0
                SEQ
                  control.register ! 0   -- reset
                  control.register ! 1   -- unreset
              TRUE
                SKIP
```

```
            20
              --{{{  monitor event request pin
              INT any :
              BOOL continue :
              SEQ
                continue := TRUE
                WHILE continue
                  PRI ALT
                    from.host ? any
                      continue := FALSE
                    sync ? any
                      test ! 0
              --}}}

            ELSE
              SKIP
          --}}}
:
```

2.2.3. Gamma-injection circuitry

A requirement for the real-time testing of gamma-circumvention hardware and algorithms has been identified. Unfortunately, the high data rates (greater than 500 frames per second) have in the past made this impracticable. Georgia Tech's Computer Engineering Research Laboratory has proposed an implementation that could provide testing at rates approaching 500 frames per second for FPA windows of size 32x32.

Our initial approach is to use the current output of the Seeker Scene Emulator at rates up to 100 frames per second. A new module will then resample this output at a 5 times rate, and add noise with a distribution equivalent to that of the modeled gamma noise.

Operation of the circuit would rely upon several banks or RAM to store the current output frame from the SSE. These banks would then be accessed in parallel at a total rate of 500 frames per second. Parallel bank access is critical to keeping the chip access time to a reasonable level. For a 500 fps, 32x32 window, the average access rate would be approximately 2 ns per pixel. Therefore, 16 banks of chips could be used to provide attainable access rates of 32 ns per pixel.

As the data is read out of the SSE, a bank of custom circuits will generate gamma-noise and add it to, or replace, the pixel data stream. The new data stream will then be demultiplexed to the required number of output channels.

2.3. Software components

There are several software components making up the operation of the Seeker Scene Emulator. First, there is the run-time code used for loading pre-calculated data, communicating with the PFP, and generating the precisely timed output data. This code is listed in Appendix A, with the code for each processor listed as a separate text file. The master configuration file is "seeker.pgm".

Additionally, an off-line data generation program is currently required by the SSE. This program takes trajectory data, scene descriptions, and focal plane array characteristics, and generates the Target and Fixed-pattern noise data files.

Finally, we are developing another program for the testing of Signal and Object Processing algorithms. This will be a non-real-time implementation that allows the user to generate a wide variety of patterns and structures. This program will provide a developer with the capability of testing specific capabilities or weaknesses of an algorithm without trying to configure an intercept scenario for the same purpose.

2.3.1. Seeker Scene Emulator operation

The Seeker Scene Emulator is designed to provide emulation of focal plane arrays of 128x128 elements at rates up to 100 frames per second. As such, the requirements for data processing are very tight, with data spread over hundreds of processors. Additionally, there are nearly 20

different programs running at one time on the entire SSE. Although, the coding for the SSE has been presented in previous annual reports, Appendix A lists the updated source code. Extensive modifications have been made for loading data and for incorporation of the GT-SPI.

2.3.2. Seeker Scene Emulator Data Generation

The Seeker Scene Emulator uses target and fixed-pattern noise data files that have been generated assuming a perfect line-of-sight. This data is obtained from by providing an intercept trajectory, scene description and focal plane characteristics to some off-line focal plane array simulator. Currently, BDM's ESSING program is used for this, however, we are investigating the use of the Strategic Scene Generation Model (SSGM) as a front-end for this operation.

2.3.2.1. ESSING

BDM Corporation has delivered to Georgia Tech a focal plane array simulation program suitable for data generation for the Georgia Tech Seeker Scene Emulator. This program uses knowledge of RV description, interceptor focal plane characteristics, time, and object position and orientation, to develop a rendering of the image as seen by a focal plane array.

In some respects, a more advanced program is BDM's EXOSEEK Version 2.0. An illustration of the data sources used in the generation of its image is shown in Figure 4. We are requesting that the ESSING program be updated to include all of the capabilities of EXOSEEK Version 2.0, as this would provide us with more accurate emulations of LATS hardware, for example focal plane array dithering (Figure 5).

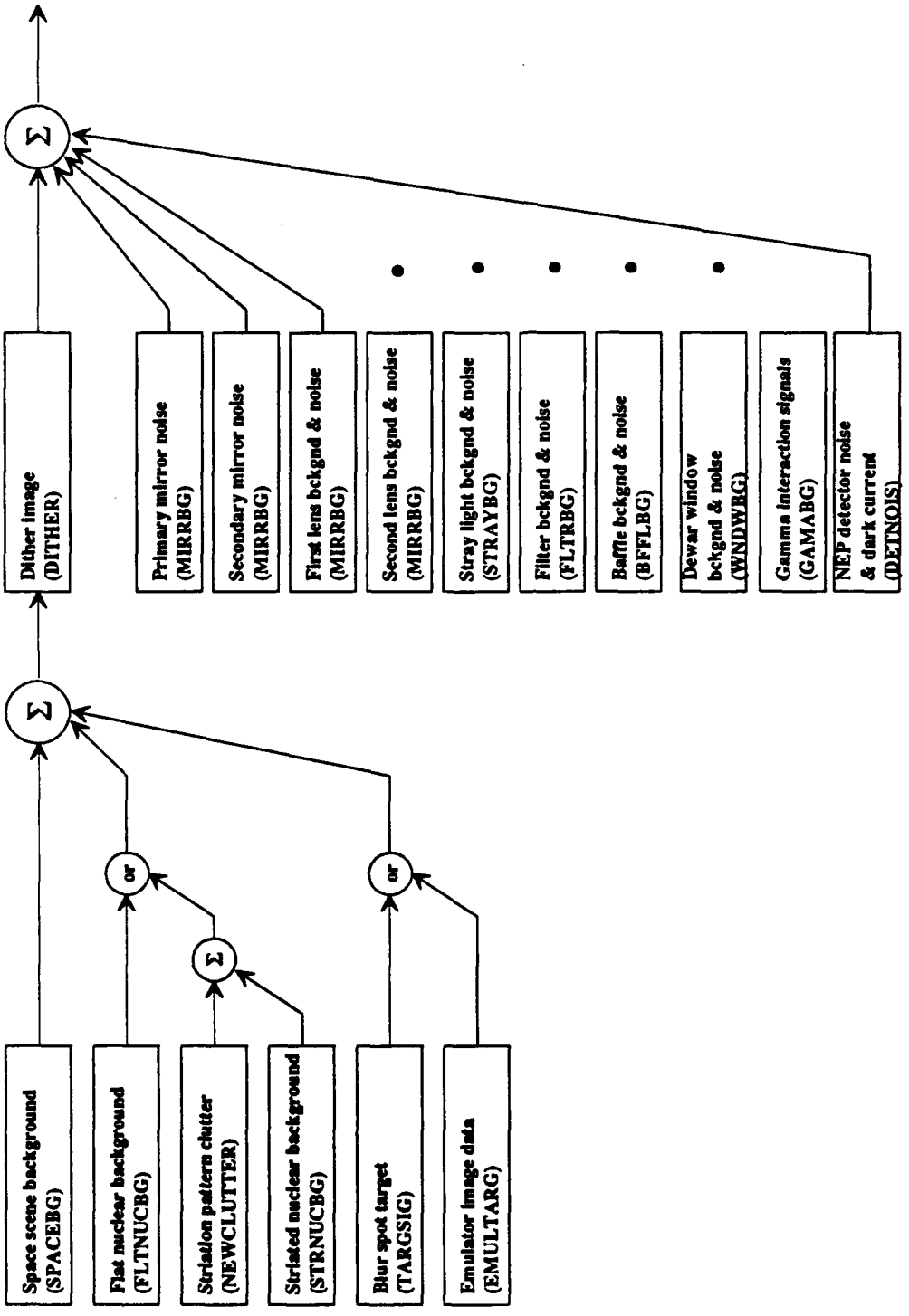

Figure 4: EXOSEEK 2 Data Sources

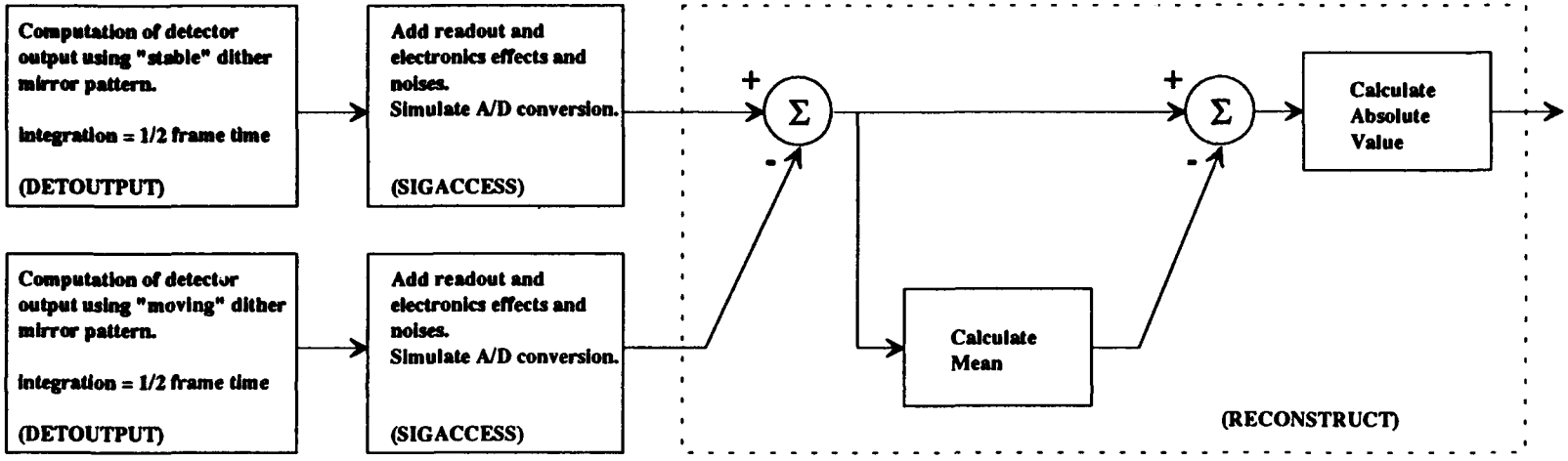

Figure 5: EXOSEEK 2 Dithering

2.3.2.2. Strategic Scene Generation Model

A validated source of input data to the Seeker Scene Emulator is very important. By using the Strategic Scene Generation Model (SSGM) and an appropriate seeker transfer function, the SSE could provide real-time, high-fidelity, validated emulations of LWIR focal plane arrays seekers.

Teledyne Brown Engineering has delivered a set of SSGM-generated data files for testing with the SSE. The SSGM raw image output has been processed by a TBE created LATS-approximate seeker transfer function. We are proposing that a completely LATS compatible seeker transfer function be developed either from TBE's work or BDM's EXOSEEK work.

2.3.3. Scene generation for Signal Processing testing

To provide the Signal Processing algorithm and hardware developer with a convenient method of testing devices and programming, we are developing tools for generating simple and complex scenes. These tools allow a user to build sequences of images using a small set of graphic primitives. The program has been implemented on a Personal Computer with VGA quality graphics, and is currently being ported to the Seeker Scene Emulator with the GT-SPI SSE/Signal Processing Interface. This interface will permit the direct testing of hardware through the program.

The program accepts two data files: an object description file and a scenario construction file. The object file describes bitmaps and polygons that can be placed upon the simulated focal plane array. The scenario construction data file specifies placement, color, and scaling of objects, placement methods, and noise and special effects sources. The scenario includes information describing the beginning and ending of frames and, in the future, timing of frame display. Table 2 describes the currently defined keywords and their meanings.

Table 2: SP Test Keywords

Keyword	Description
Object	Specifies that the following tokens describe a placeable object
Polygon	Scalable object type made up of n connected line segments
Bitmap	Non-scalable object. Array of points (up to 8x8) with relative intensities
NewFrame	Clear the frame buffer and, depending upon implementation, write old frame to output device

Place	Write object into frame buffer at the specified location,size, and intensity
Array	Replicate the last Place command in a two-dimensional manner
Repeat	Replicate the last Place command in a linear-manner
Noise	Place a rectangular patch of noise into the frame buffer using the specified location and size. If no Noise Model has been selected, a uniform distribution is assumed.
Lorentzian	Lorentzian distribution noise model
Gaussian	Gaussian distribution noise model
Uniform	Uniform distribution noise model
Add	Mode of placing information into the frame buffer where new data is added to old data
Overlay	Mode of placing information into the frame buffer where new data replaces old data
Mask	Limit placement operation to non-zero pixels
NoMask	Clear mask conditions
UnMask	Limit placement operation to zeroed pixels

3. Related Development Efforts

The following sections describe programs that are peripherally related to the Seeker Scene Emulator development.

3.1. Neural net investigation

We have received a copy of the NNETS neural network test software developed by NASA. This software was written for the Transputer using the language C. We will move this onto a subset of the Seeker Scene Emulator and attempt to perform some signal and object processing with it.

3.2. Advanced Signal Processing Testbed

The Advanced Signal Processing Testbed is being developed to facilitate the testing and design of Signal Processing algorithms and implementations. The testbed will consist of a number of next-generation T9000 Transputers with 200 MIPS and 25 MFLOPS capability. We expect to achieve real-time or near real-time emulation of many of the currently developed algorithms.

3.3. LATS interface

We have developed a multi-processor clustering implementation which, for small arrays, duplicates the functionality of the Georgia Tech Clustering and Centroiding chips. this implementation can cluster and centroid a 32x32 pixel data stream at 100 frames per second. In order to provide LMSC with the capability of performing real-time closed-loop testing of the LATS FPA and signal processing hardware, we are developing an interface between the LATS testbed and our multi-processor clustering and centroiding unit. This interface, shown in Figure 6 will consist of the Inmos Transputers needed for the object processing along with a commercially-available Transputer-to-SCSI interface.

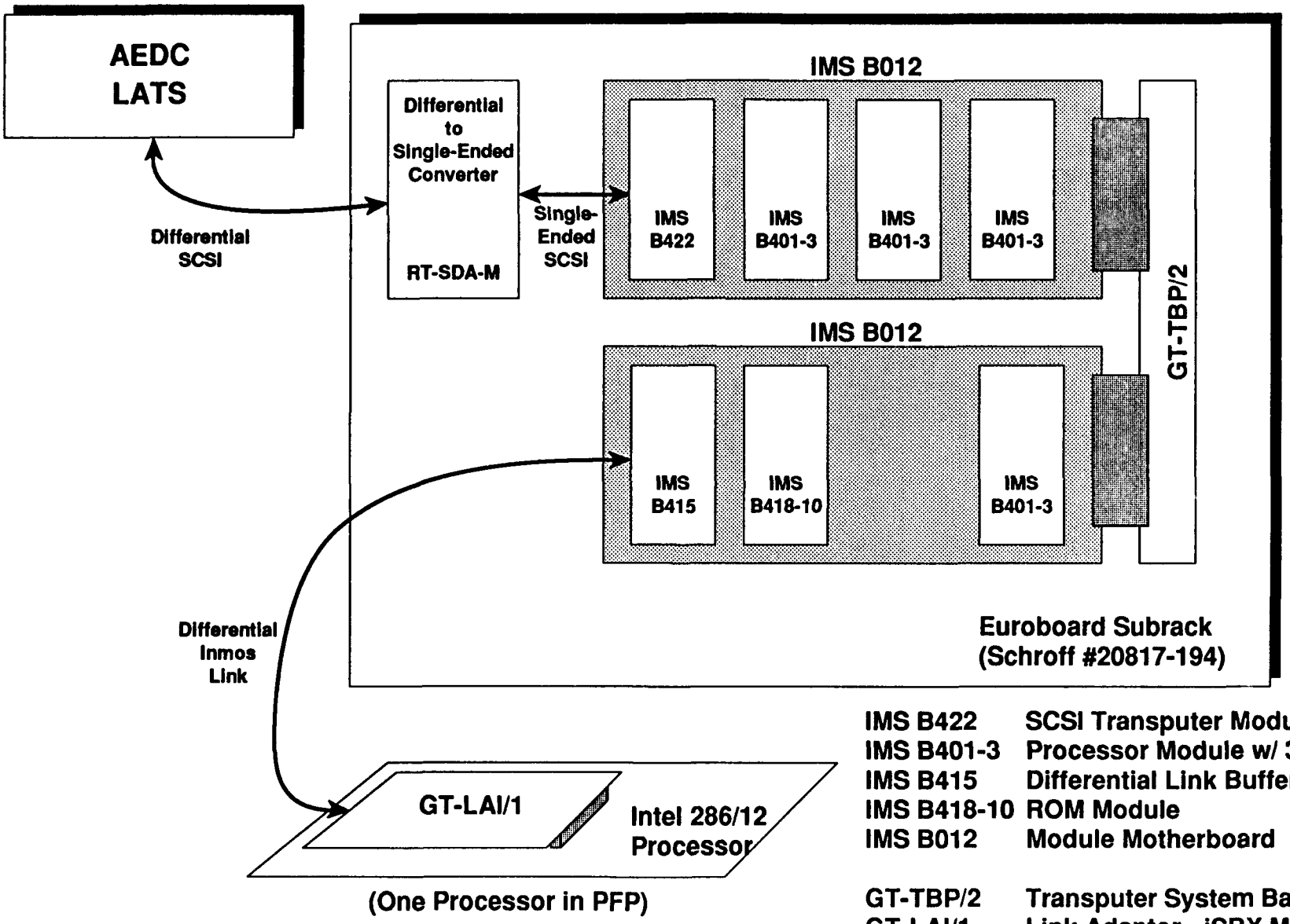

Figure 6: LATS Interface

4. Appendix A: Seeker Scene Emulator Source Code

4.1. Occam Source Code

4.1.1. Seeker.pgm

```
--{{{  SC HostSeek
--:::A  4 10
#USE "HostSeek.c8h"
--{{{F HostSeek
--:::F hostseek.OCC
--}}}
--}}}
--{{{  SC Controller
--:::A  4 10
#USE "controll.t8h"
--{{{F Controller
--:::F CONTROLL.OCC
--}}}
--}}}
--{{{  SC Guidance
--:::A  4 10
#USE "guidance.t8h"
--{{{F Guidance
--:::F GUIDANCE.OCC
--}}}
--}}}
--{{{  SC XBar
--:::A  4 10
#USE "xbar.t2h"
--{{{F XBar
--:::F XBAR.OCC
--}}}
--}}}
--{{{  SC GTSPI
#USE "gtspi.t2h"
--{{{F gtspi.occ
--:::F GTSPI.OCC
--}}}
--}}}
--{{{  SeekerEmulator
#USE "gtsei.t2h"
--{{{  SC GTSEI
--:::A  4 10
--{{{F gtsei.occ
--:::F GTSEI.OCC
--}}}
--}}}

#USE "backgrou.t8h"
--{{{  SC Background
--:::A  4 10
--{{{F Background
--:::F BACKGROU.OCC
--}}}
--}}}

#USE "targetle.t8h"
--{{{  SC TargetLead
--:::A  4 10
--{{{F TargetLead
--:::F TARGETLE.OCC
--}}}
--}}}
```

```
#USE "target.t8h"
--{{{  SC Target
--:::A  4 10
--{{{F Target
--:::F TARGET.OCC
--}}}
--}}}
--}}}
--{{{  SignalProcessing
#USE "spcontro.t8h"
--{{{  SC SPController
--:::A  4 10
--{{{F SPController
--:::F SPCONTRO.OCC
--}}}
--}}}
#USE "sp.t4h"
--{{{  SC SP
--:::A  4 10
--{{{F SP
--:::F SP.OCC
--}}}
--}}}
--}}}
--{{{  Graphics
#USE "firstbuf.t8h"
--{{{  SC FirstBuffer
--:::A  4 10
--{{{F FirstBuffer
--:::F FIRSTBUF.OCC
--}}}
--}}}

#USE "secondbu.t8h"
--{{{  SC SecondBuffer
--:::A  4 10
--{{{F SecondBuffer
--:::F SECONDBU.OCC
--}}}
--}}}

#USE "formatte.t8h"
--{{{  SC Formatter
--:::A  4 10
--{{{F Formatter
--:::F FORMATTE.OCC
--}}}
--}}}

#USE "imagedis.c8h"
--{{{  SC ImageDisplay
--:::A  4 10
--{{{F ImageDisplay
--:::F IMAGEDIS.OCC
--}}}
--}}}

#USE "trackdis.c8h"
--{{{  SC TrackDisplay
--:::A  4 10
--{{{F TrackDisplay
--:::F TRACKDIS.OCC
--}}}
--}}}

#USE "b409stub.c2h"
--{{{  SC B409.stub
```

```
--:::A  4 10
--{{{F B409stub
--:::F B409stub.OCC
--}}}
--}}}
--}}}
--{{{  configuration
--{{{  constants
VAL  image.shift  IS  9 :
--}}}
--{{{  link definitions
VAL  link0out    IS  0 :
VAL  link1out    IS  1 :
VAL  link2out    IS  2 :
VAL  link3out    IS  3 :
VAL  link0in     IS  4 :
VAL  link1in     IS  5 :
VAL  link2in     IS  6 :
VAL  link3in     IS  7 :
--}}}
--{{{  channels
CHAN OF ANY   Controller.Host,        Host.Controller       :
CHAN OF ANY   Controller.GTSEI,       GTSEI.Controller      :
CHAN OF ANY   Controller.SPC,         SPC.Controller        :
CHAN OF ANY   Crossbar0,              Crossbar1             :
CHAN OF ANY   Guidance.XBar,          XBar.Guidance         :
CHAN OF ANY   Guidance.SPController,  SPController.Guidance :
CHAN OF ANY   SPController.Graphics,  Graphics.SPController :

[16][8]  CHAN OF ANY  Target.up,      Target.down  :
[16]     CHAN OF ANY  Target.forward, Target.back  :
[16]     CHAN OF ANY  Target.GTSEI,   GTSEI.BG     :
[17]     CHAN OF ANY  BG.forward,     BG.back      :
[16]     CHAN OF ANY  BG.SP                        :
[16]     CHAN OF ANY  Graphics.SP,    SP.Graphics  :
[17]     CHAN OF ANY  SP.forward,     SP.back      :

[9]      CHAN OF ANY  Extract0, Extract1, Extract2, Extract3, Extract4,
                      Extract5 :
[4]      CHAN OF ANY  Format.Graphics :
[4]      CHAN OF ANY  Graphics.forward, Graphics.back :
--}}}
PLACED PAR
  --{{{  HostSeeker
  PROCESSOR 1000 T8
    PLACE Host.Controller   AT link2out :
    PLACE Controller.Host   AT link2in :
    HostSeeker (Controller.Host, Host.Controller)
  --}}}
  --{{{  Controller
  PPOCESSOR  0  T8

    PLACE  Host.Controller      AT  link1in  :
    PLACE  GTSEI.Controller     AT  link3in  :
    PLACE  BG.back[0]           AT  link0in  :
    PLACE  SPC.Controller       AT  link2in  :
    PLACE  Controller.Host      AT  link1out :
    PLACE  Controller.GTSEI     AT  link3out :
    PLACE  BG.forward[0]        AT  link0out :
    PLACE  Controller.SPC       AT  link2out :

    Controller( Host.Controller,       Controller.Host,
                GTSEI.Controller,      Controller.GTSEI,
                BG.back[0],            BG.forward[0],
                SPC.Controller,        Controller.SPC  )
  --}}}
  --{{{  Guidance
```

```
PROCESSOR  1  T8

  PLACE  SPController.Guidance     AT  link1in  :
  PLACE  XBar.Guidance             AT  link0in  :
  PLACE  Guidance.SPController     AT  link1out :
  PLACE  Guidance.XBar             AT  link0out :

  Guidance( SPController.Guidance, Guidance.SPController,
            XBar.Guidance,         Guidance.XBar          )
--}}}
--{{{  XBar
PROCESSOR  2  T2

  PLACE  Guidance.XBar   AT  link1in  :
  PLACE  XBar.Guidance   AT  link1out :

  XBar( Guidance.XBar,  XBar.Guidance )
--}}}
--{{{  Signal Processing Interface
--}}}
--{{{  SeekerEmulator
--{{{  GTSEI
PROCESSOR  3  T2

  PLACE  Controller.GTSEI     AT  link1in  :
  PLACE  Target.back[0]       AT  link2in  :
  PLACE  GTSEI.Controller     AT  link1out :
  PLACE  Target.forward[0]    AT  link2out :
  PLACE  Crossbar0            AT  link0out :
  PLACE  Crossbar1            AT  link3out :

  GTSEI( Controller.GTSEI,   GTSEI.Controller,
         Target.back[0],     Target.forward[0],
         Crossbar0,          Crossbar1          )
--}}}
--{{{  GTSPI
PROCESSOR  4  T2

  PLACE  Extract4[0]   AT  link0in  :
  PLACE  Extract5[0]   AT  link1in :

  GTSPI( Extract4[0], Extract5[0] )
--}}}
--{{{  Background
PLACED PAR i = 0 FOR 16

  PROCESSOR  10+i  T8

    PLACE  GTSEI.BG[i]         AT  link3in  :
    PLACE  BG.forward[i]       AT  link1in  :
    PLACE  BG.back[i+1]        AT  link2in  :
    PLACE  BG.SP[i]            AT  link0out :
    PLACE  BG.back[i]          AT  link1out :
    PLACE  BG.forward[i+1]     AT  link2out :

    Background( GTSEI.BG[i],       BG.SP[i],
                BG.forward[i],     BG.back[i],
                BG.back[i+1],      BG.forwar [i+1], i )
--}}}
--{{{  TargetLead
PLACED PAR i = 0 FOR 15

  PROCESSOR  30+i  T8

    PLACE  Target.down[i][0]       AT  link2in  :
    PLACE  Target.forward[i]       AT  link0in  :
    PLACE  Target.back[i+1]        AT  link3in  :
```

```
    PLACE  Target.GTSEI[i]        AT  link1out :
    PLACE  Target.up[i][0]        AT  link2out :
    PLACE  Target.back[i]         AT  link0out :
    PLACE  Target.forward[i+1]    AT  link3out :

    TargetLead( Target.down[i][0],  Target.up[i][0],   Target.GTSEI[i],
                Target.forward[i],  Target.back[i],
                Target.back[i+1],   Target.forward[i+1], i              )

PROCESSOR  45  T8
  VAL i IS 15 :
  PLACE  Target.down[i][0]      AT  link2in  :
  PLACE  Target.forward[i]      AT  link0in  :
  PLACE  BG.forward[16]         AT  link3in  :
  PLACE  Target.GTSEI[i]        AT  link1out :
  PLACE  Target.up[i][0]        AT  link2out :
  PLACE  Target.back[i]         AT  link0out :
  PLACE  BG.back[16]            AT  link3out :

  TargetLead( Target.down[i][0],  Target.up[i][0],   Target.GTSEI[i],
              Target.forward[i],  Target.back[i],
              BG.forward[16],     BG.back[16], i                      )
--}}}
--{{{  Target
PLACED PAR i= 0 FOR 16
  PLACED PAR j = 1 FOR 7

    PROCESSOR  100+((i*10)+j)  T8

      PLACE  Target.up[i][j-1]    AT  link1in  :
      PLACE  Target.down[i][j]    AT  link2in  :
      PLACE  Target.down[i][j-1]  AT  link1out :
      PLACE  Target.up[i][j]      AT  link2out :

      Target( Target.up[i][j-1],   Target.down[i][j-1],
              Target.down[i][j],   Target.up[i][j], i, j )
--}}}
--}}}
--{{{  SignalProcessing
--{{{  SPController
PROCESSOR  500  T8.

  PLACE  Controller.SPC           AT  link1in  :
  PLACE  Guidance.SPController    AT  link2in  :
  PLACE  Graphics.SPController    AT  link3in  :
  PLACE  SP.back[0]               AT  link0in  :
  PLACE  SPC.Controller           AT  link1out :
  PLACE  SPController.Guidance    AT  link2out :
  PLACE  SPController.Graphics    AT  link3out :
  PLACE  SP.forward[0]            AT  link0out :

  SPController( Controller.SPC,          SPC.Controller,
                Guidance.SPController,   SPController.Guidance,
                Graphics.SPController,   SPController.Graphics,
                SP.back[0],              SP.forward[0]          )
--}}}
--{{{  SP
PLACED PAR i = 0 FOR 16

  PROCESSOR  510+i  T4

    PLACE  Graphics.SP[i]       AT  link3in  :
    PLACE  SP.forward[i]        AT  link1in  :
    PLACE  SP.back[i+1]         AT  link2in  :
    PLACE  SP.Graphics[i]       AT  link0out :
    PLACE  SP.back[i]           AT  link1out :
    PLACE  SP.forward[i+1]      AT  link2out :
```

```
    SP( Graphics.SP[i],       SP.Graphics[i],
        SP.forward[i],        SP.back[i],
        SP.back[i+1],         SP.forward[i+1], i )
--}}}
--}}}
--{{{  Graphics
--{{{  FirstBuffer
PLACED PAR i = 0 FOR 8

  PROCESSOR  600+i  T8

    PLACE  BG.SP[i]          AT  link3in  :
    PLACE  Extract0[i+1]     AT  link2in  :
    PLACE  Graphics.SP[i]    AT  link0out :
    PLACE  Extract0[i]       AT  link1out :

    FirstBuffer( BG.SP[i],          Graphics.SP[i],
                 Extract0[i+1],     Extract0[i],     i, image.shift )

PLACED PAR i = 0 FOR 8

  PROCESSOR  608+i  T8

    PLACE  BG.SP[i+8]        AT  link3in  :
    PLACE  Extract1[i+1]     AT  link1in  :
    PLACE  Graphics.SP[i+8]  AT  link0out :
    PLACE  Extract1[i]       AT  link2out :

    FirstBuffer( BG.SP[i+8],        Graphics.SP[i+8],
                 Extract1[i+1],     Extract1[i],      i, image.shift )
--}}}
--{{{  SecondBuffer
PLACED PAR i = 0 FOR 8

  PROCESSOR  620+i  T8

    PLACE  SP.Graphics[i]    AT  link3in  :
    PLACE  Extract2[i+1]     AT  link2in  :
    PLACE  Extract2[i]       AT  link1out :
    PLACE  Extract4[i]       AT  link0out :

    SecondBuffer( SP.Graphics[i],
                  Extract2[i+1],    Extract2[i], Extract4[i],
                  i, image.shift )

PLACED PAR i = 0 FOR 8

  PROCESSOR  628+i  T8

    PLACE  SP.Graphics[i+8]  AT  link3in  :
    PLACE  Extract3[i+1]     AT  link1in  :
    PLACE  Extract3[i]       AT  link2out :
    PLACE  Extract5[i]       AT  link0out :

    SecondBuffer( SP.Graphics[i+8],
                  Extract3[i+1],    Extract3[i], Extract5[i], i, image.shift )
--}}}
--{{{  Formatters
PROCESSOR  640  T8

  PLACE  Extract0[0]         AT  link0in  :
  PLACE  Format.Graphics[0]  AT  link1out :

  Formatter( Extract0[0],  Format.Graphics[0] )
```

```
PROCESSOR  641  T8

  PLACE  Extract1[0]        AT  link0in  :
  PLACE  Format.Graphics[1] AT  link1out :

  Formatter( Extract1[0],  Format.Graphics[1] )


PROCESSOR  642  T8

  PLACE  Extract2[0]        AT  link0in  :
  PLACE  Format.Graphics[2] AT  link1out :

  Formatter( Extract2[0],  Format.Graphics[2] )


PROCESSOR  643  T8

  PLACE  Extract3[0]        AT  link0in  :
  PLACE  Format.Graphics[3] AT  link1out :

  Formatter( Extract3[0],  Format.Graphics[3] )
--}}}
--{{{  ImageDisplays
PROCESSOR  650  T8

  CHAN OF ANY temp1, temp2 :
  PLACE  Format.Graphics[0]     AT  link1in  :
  PLACE  Format.Graphics[1]     AT  link2in  :
  PLACE  Graphics.back[1]       AT  link3in  :
  PLACE  Graphics.forward[2]    AT  link0in  :
  PLACE  Graphics.forward[1]    AT  link3out :
  PLACE  Graphics.back[2]       AT  link0out :

  ImageDisplay( Format.Graphics[0],   Format.Graphics[1],
                Graphics.back[1], Graphics.forward[1],
                Graphics.forward[2],  Graphics.back[2], 0,  1000   )

PROCESSOR  651  T8

  PLACE  Format.Graphics[2]     AT  link2in  :
  PLACE  Format.Graphics[3]     AT  link1in  :
  PLACE  Graphics.back[2]       AT  link3in  :
  PLACE  Graphics.forward[3]    AT  link0in  :
  PLACE  Graphics.forward[2]    AT  link3out :
  PLACE  Graphics.back[3]       AT  link0out :

  ImageDisplay( Format.Graphics[2],   Format.Graphics[3],
                Graphics.back[2],     Graphics.forward[2],
                Graphics.forward[3],  Graphics.back[3], 1,  1000   )
--}}}
--{{{  TrackDisplay
PROCESSOR  652  T8

  PLACE  SPController.Graphics   AT  link1in  :
  PLACE  Graphics.back[0]        AT  link3in  :
  PLACE  Graphics.forward[1]     AT  link0in  :
  PLACE  Graphics.SPController   AT  link1out :
  PLACE  Graphics.forward[0]     AT  link3out :
  PLACE  Graphics.back[1]        AT  link0out :

  TrackDisplay( SPController.Graphics,  Graphics.SPController,
                Graphics.back[0],       Graphics.forward[0],
                Graphics.forward[1],    Graphics.back[1]       )
--}}}
--{{{  B409
PROCESSOR  660  T2
```

```
    PLACE  Graphics.forward[0]  AT  link0in  :
    PLACE  Graphics.back[0]     AT  link0out :

    B409.stub( Graphics.forward[0], Graphics.back[0] )
  --}}}
  --}}}
--}}}
```

4.1.2. B409.occ

```
--{{{  SC B409
--:::A  3 10
--{{{  B409
#INCLUDE "crtc.inc"
PROC B409 ( CHAN OF CRTC command )

  --{{{  defs
  VAL bpw.shift IS 1:
  VAL mint IS #8000:
  --}}}
  --{{{  pointers to hardware registers
  VAL ChannelModeSelect.p     IS #B000:
  --{{{  ChannelA defs
  VAL ChannelAPixelAddressW.p IS #0000:
  VAL ChannelAColorValue.p    IS #0400:
  VAL ChannelAPixelMask.p     IS #0800:
  VAL ChannelAPixelAddressR.p IS #0C00:
  --}}}
  --{{{  ChannelB defs
  VAL ChannelBPixelAddressW.p IS #1000:
  VAL ChannelBColorValue.p    IS #1400:
  VAL ChannelBPixelMask.p     IS #1800:
  VAL ChannelBPixelAddressR.p IS #1C00:
  --}}}
  --{{{  ChannelC defs
  VAL ChannelCPixelAddressW.p IS #2000:
  VAL ChannelCColorValue.p    IS #2400:
  VAL ChannelCPixelMask.p     IS #2800:
  VAL ChannelCPixelAddressR.p IS #2C00:
  --}}}
  VAL ParameterFIFO.p         IS #A000:
  VAL StatusRegister.p        IS #A000:
  VAL CommandFIFO.p           IS #A002:
  VAL FIFORead.p              IS #A002:
  --}}}
  --{{{  hardware placements
  INT ChannelModeSelect     :
  --{{{  ChannelA declarations
  INT ChannelAPixelAddressW :
  INT ChannelAColorValue    :
  INT ChannelAPixelMask     :
  INT ChannelAPixelAddressR :
  --}}}
  --{{{  ChannelB declarations
  INT ChannelBPixelAddressW :
  INT ChannelBColorValue    :
  INT ChannelBPixelMask     :
  INT ChannelBPixelAddressR :
  --}}}
  --{{{  ChannelC declarations
  INT ChannelCPixelAddressW :
  INT ChannelCColorValue    :
  INT ChannelCPixelMask     :
  INT ChannelCPixelAddressR :
  --}}}
  INT ParameterFIFO         :
  INT StatusRegister        :
  INT CommandFIFO           :
  INT FIFORead              :
  --{{{  ChannelA placements
  PLACE ChannelAPixelAddressW AT (ChannelAPixelAddressW.p >< mint) >> bpw.shift :
  PLACE ChannelAColorValue    AT (ChannelAColorValue.p    >< mint) >> bpw.shift :
  PLACE ChannelAPixelMask     AT (ChannelAPixelMask.p     >< mint) >> bpw.shift :
  PLACE ChannelAPixelAddressR AT (ChannelAPixelAddressR.p >< mint) >> bpw.shift :
```

```
--}}}
--{{{  ChannelB placements
PLACE ChannelBPixelAddressW AT (ChannelBPixelAddressW.p >< mint) >> bpw.shift :
PLACE ChannelBColorValue    AT (ChannelBColorValue.p    >< mint) >> bpw.shift :
PLACE ChannelBPixelMask     AT (ChannelBPixelMask.p     >< mint) >> bpw.shift :
PLACE ChannelBPixelAddressR AT (ChannelBPixelAddressR.p >< mint) >> bpw.shift :
--}}}
--{{{  ChannelC placements
PLACE ChannelCPixelAddressW AT (ChannelCPixelAddressW.p >< mint) >> bpw.shift :
PLACE ChannelCColorValue    AT (ChannelCColorValue.p    >< mint) >> bpw.shift :
PLACE ChannelCPixelMask     AT (ChannelCPixelMask.p     >< mint) >> bpw.shift :
PLACE ChannelCPixelAddressR AT (ChannelCPixelAddressR.p >< mint) >> bpw.shift :
--}}}
PLACE ChannelModeSelect     AT (ChannelModeSelect.p     >< mint) >> bpw.shift :
PLACE ParameterFIFO         AT (ParameterFIFO.p         >< mint) >> bpw.shift :
PLACE StatusRegister        AT (StatusRegister.p        >< mint) >> bpw.shift :
PLACE CommandFIFO           AT (CommandFIFO.p           >< mint) >> bpw.shift :
PLACE FIFORead              AT (FIFORead.p              >< mint) >> bpw.shift :
--}}}
--{{{  CRTC commands
VAL CTRCReset IS #00:
VAL CTRCBctrl IS #0D:
--}}}
--{{{  set.colour
PROC set.colour ( VAL INT channel, colour, red, green, blue )
  -- set up a colour in the G170 colour look up table
  CASE channel
    INT channel.A
      --{{{
      SEQ
        ChannelAPixelAddressW := 255  - (colour /\ #FF)
        ChannelAColorValue := red
        ChannelAColorValue:= green
        ChannelAColorValue := blue
      --}}}
    INT channel.B
      --{{{
      SEQ
        ChannelBPixelAddressW := 255  - (colour /\ #FF)
        ChannelBColorValue := red
        ChannelBColorValue:= green
        ChannelBColorValue := blue
      --}}}
    INT channel.C
      --{{{
      SEQ
        ChannelCPixelAddressW := 255  - (colour /\ #FF)
        ChannelCColorValue := red
        ChannelCColorValue:= green
        ChannelCColorValue := blue
      --}}}
:
--}}}
--{{{  writeCRTC
PROC writeCRTC(INT address, VAL INT data)
  TIMER time:
  INT now:
  SEQ
    address := data
    time ? now
    time ? AFTER (now PLUS 2)
:
--}}}
--{{{  init.G170
PROC init.G170 (VAL INT channel, table)
  INT red, green, blue:
  SEQ
```

```
ChannelAPixelMask := #FF
IF
  --{{{  table 0
  table = 0
    VAL scale IS [0, 18, 36, 54] :
    VAL bias IS 9 :
    SEQ
      set.colour (channel, 0, 0, 0, 0)       -- black
      SEQ i = 1 FOR 255
        INT ix :
        SEQ
          blue := scale[(i>>4)/\3]
          green := scale[(i>>2)/\3]
          red := scale[i/\3]
          IF
            i >= #C0
              blue := blue + bias
            i >= #80
              green := green + bias
            i >= #40
              red := red + bias
            TRUE
              SKIP
          CASE channel
            --{{{  channel.A
            INT channel.A
              SEQ
                ChannelAColorValue := red
                ChannelAColorValue := green
                ChannelAColorValue := blue
            --}}}
            --{{{  channel.B
            INT channel.B
              SEQ
                ChannelBColorValue := red
                ChannelBColorValue := green
                ChannelBColorValue := blue
            --}}}
            --{{{  channel.C
            INT channel.C
              SEQ
                Cha  nelCColorValue := red
                Cha  nelCColorValue := green
                ChannelCColorValue := blue
            --}}}
  --}}}
  --{{{  COMMENT table 1
  --:::A  0 0
  --{{{  table 1
  table = 1
    SEQ
      --{{{    0  -   15 grey scale
      red := -1
      green := -1
      blue := -1
      SEQ i = 0 FOR 16
        SEQ
          red := red + 4
          green := green + 4
          blue := blue + 4
          set.colour (channel, i, red, green, blue)
      --}}}
      --{{{   16  -   32 red scale
      red := -1
      green := 0
      blue := 0
      SEQ i = 16 FOR 16
```

```
    SEQ
      red := red + 4
      set.colour (channel, i, red, green, blue)
--}}}
--{{{   32  -   47 green scale
red := 0
green := -1
blue := 0
SEQ i = 32 FOR 16
  SEQ
    green := green + 4
    set.colour (channel, i, red, green, blue)
--}}}
--{{{   48  -   63 blue scale
red := 0
green := 0
blue := -1
SEQ i = 48 FOR 16
  SEQ
    blue := blue + 4
    set.colour (channel, i, red, green, blue)
--}}}
--{{{   64  -   79 yellow scale
red := -1
green := -1
blue := 0
SEQ i = 64 FOR 16
  SEQ
    red := red + 4
    green := green + 4
    set.colour (channel, i, red, green, blue)
--}}}
--{{{   80  -   95 cyan scale
red := 0
green := -1
blue := -1
SEQ i = 80 FOR 16
  SEQ
    green := green + 4
    blue := blue + 4
    set.colour (channel, i, red, green, blue)
--}}}
--{{{   96  -  111 magenta scale
red := -1
green := 0
blue := -1
SEQ i = 96 FOR 16
  SEQ
    red := red + 4
    blue := blue + 4
    set.colour (channel, i, red, green, blue)
--}}}
--{{{  112  -  127 red & green scale with third blue
red := 63
green := -1
blue := 21
SEQ i = 112 FOR 16
  SEQ
    green := green + 4
    set.colour (channel, i, red, green, blue)
    red := red - 4
--}}}
--{{{  128  -  143 green & blue scale with third red
red := 21
green := 63
blue := -1
SEQ i = 128 FOR 16
```

```
  SEQ
    blue := blue + 4
    set.colour (channel, i, red, green, blue)
    green := green - 4
--}}}
--{{{  144  -  159 blue & redscale with third green
red := -1
green := 21
blue := 63
SEQ i = 144 FOR 16
  SEQ
    red := red + 4
    set.colour (channel, i, red, green, blue)
    blue := blue - 4
--}}}
--{{{  160  -  175 red & green scale with two-thirds blue
red := 63
green := -1
blue := 42
SEQ i = 160 FOR 16
  SEQ
    green := green + 4
    set.colour (channel, i, red, green, blue)
    red := red - 4
--}}}
--{{{  176  -  191 green & blue scale with two-thirds red
red := 42
green := 63
blue := -1
SEQ i = 176 FOR 16
  SEQ
    blue := blue + 4
    set.colour (channel, i, red, green, blue)
    green := green - 4
--}}}
--{{{  192  -  207 blue & red scale with two-thirds green
red := -1
green := 42
blue := 63
SEQ i = 192 FOR 16
  SEQ
    red := red + 4
    set.colour (channel, i, red, green, blue)
    blue := blue - 4
--}}}
--{{{  208  -  223 red & green scale with full blue
red := 63
green := -1
blue := 63
SEQ i = 208 FOR 16
  SEQ
    green := green + 4
    set.colour (channel, i, red, green, blue)
    red := red - 4
--}}}
--{{{  224  -  239 green & blue scale with full red
red := 63
green := 63
blue := -1
SEQ i = 224 FOR 16
  SEQ
    blue := blue + 4
    set.colour (channel, i, red, green, blue)
    green := green - 4
--}}}
--{{{  240  -  255 blue & red scale with full green
red := -1
```

```
            green := 63
            blue := 63
            SEQ i = 240 FOR 16
              SEQ
                red := red + 4
                set.colour (channel, i, red, green, blue)
                blue := blue - 4
            --}}}
        --}}}
        --}}}
        TRUE
          SKIP
:
--}}}
--{{{  set.timing
PROC set.timing( VAL INT16 width, height, frame.frequency,
                 VAL INT32 line.frequency, pixel.clock,
                 VAL BOOL  interlace )

  --{{{  variables
  INT AW, HBP, HFP, HS:
  INT horizontal.cells, flyback:
  INT AL, SL,  VFP, VS, VBP:
  --}}}
  SEQ
    --{{{  calculate horizontal timing
    horizontal.cells := INT((pixel.clock / line.frequency)>> 5)
    AW := ((INT width) >> 5)
    --{{{  COMMENT
    --:::A  0 0
    --{{{
    IF
      AW > (horizontal.cells - (horizontal.cells/5)) -- 80%
        STOP   -- Display set too wide
      TRUE
        SKIP
    --}}}
    --}}}
    flyback := horizontal.cells - AW
    HBP := flyback >> 1
    HFP := (flyback - HBP) >> 1
    HS :=  HBP - HFP
    --}}}
    --{{{  calculate vertical timing
    SL := INT (line.frequency / (INT32 frame.frequency))
    IF
      (INT height) > 1024
        AL := 1024
      TRUE
        AL := (INT height)
    --{{{  COMMENT test numbers
    --:::A  0 0
    --{{{  test numbers
    IF
      (INT AL) > (SL - (SL/5)) -- 80%
        STOP -- Image is set too tall for frame rate
      TRUE
        SKIP
    --}}}
    --}}}
    flyback := SL - (INT height)
    VFP := 3
    VS := 3
    VBP := flyback - 6
    --}}}
    --{{{  send video timing
    writeCRTC(CommandFIFO, CTRCReset)
```

```
      IF
        interlace
          writeCRTC(ParameterFIFO, #1B)
        TRUE
          writeCRTC(ParameterFIFO, #12)
      writeCRTC(ParameterFIFO, ((AW - 2) /\ #FE))
      writeCRTC(ParameterFIFO, (HS - 1) \/ ((VS /\ 7) << 5))
      writeCRTC(ParameterFIFO, ((VS /\ #18) >> 3) \/ ((HFP -1) << 2))
      writeCRTC(ParameterFIFO, (HBP - 1) /\ #3F)
      writeCRTC(ParameterFIFO, VFP /\ #3F)
      writeCRTC(ParameterFIFO, AL /\ #FF)
      writeCRTC(ParameterFIFO, ((AL /\ #0300) >> 8) \/ (VBP << 2))
      --}}}
      --{{{  unblank display & select mode
      writeCRTC(CommandFIFO, CTRCBctrl)
      ChannelModeSelect := 1
      --}}}
  :
  --}}}
  --{{{  locals
  INT16 width, height, frame.frequency:
  INT32 line.frequency, pixel.clock:
  BOOL interlace, running:
  INT16 channel, pixel, red, green, blue, table:
  --}}}
  SEQ
    --{{{  command interpreter
    running := TRUE
    init.G170( INT channel.A, 0 )
    init.G170( INT channel.B, 0 )
    init.G170( INT channel.C, 0 )
    WHILE running
      command ? CASE
        crtc.init; width; height; line.frequency;
                   frame.frequency; pixel.clock; interlace
          set.timing( width, height, frame.frequency,
                      line.frequency, pixel.clock, interlace )
        crtc.color; channel; pixel; red; green; blue
          set.colour((INT channel), (INT pixel),
                     (INT red), (INT green), (INT blue))
        crtc.initLUT; channel; table
          init.G170((INT channel), (INT table))
        crtc.stop
          running := FALSE
    --}}}
:
--}}}
--}}}
```

4.1.3. B409Stub.occ

```
PROC B409.stub ( CHAN OF ANY  in, out )

  #INCLUDE "crtc.inc"
  #USE "graphics.lib"
  B409( in )
:
```

4.1.4. Background.occ

```
PROC Background ( CHAN OF ANY fromTarget, toSP,
                            fromPrev, toPrev, fromNext, toNext,
                  VAL INT position )

  #INCLUDE "s_header.inc"
  REAL32 g.scale :
  --{{{  constants
  VAL  packet.length   IS  16 :
  VAL  num.packets     IS  (128 * 8) / packet.length :

  VAL  min.signal      IS     0 :
  VAL  max.signal      IS 65535 :
  --}}}
  --{{{  ProcessRow
  PROC ProcessRow ( [packet.length] INT data,
                    [packet.length] REAL32 back.row, gain.row, offset.row )

    [] REAL32 target RETYPES data :
    SEQ
      SEQ i = 0 FOR packet.length
        INT digital :
        SEQ
          digital := INT TRUNC( (((target[i] + back.row[i]) *
                                  gain.row[i]) + offset.row[i]) * g.scale )
          IF
            digital < min.signal
              data[i] := min.signal
            digital > max.signal
              data[i] := max.signal
            TRUE
              data[i] := digital
  :
  --}}}
  --{{{  ProcessFrame
  PROC ProcessFrame ( CHAN OF ANY in, out,
                      [128][8] REAL32 Background, Gain, Offset )

    --{{{  retype array to packet.length
    [num.packets][packet.length] REAL32  p.background  RETYPES Background :
    [num.packets][packet.length] REAL32  p.gain        RETYPES Gain       :
    [num.packets][packet.length] REAL32  p.offset      RETYPES Offset     :
    --}}}
    --{{{  variables
    INT in.ptr, out.ptr, process.ptr, temp :
    [3][packet.length] INT buffer :
    PLACE buffer IN WORKSPACE :
    --}}}
    SEQ
      in.ptr := 2
      process.ptr := 1
      out.ptr := 0
      --{{{  get first row
      in ? buffer[0]
      --}}}
      --{{{  get second row and process first row
      PRI PAR
        in ? buffer[1]
        ProcessRow( buffer[0], p.background[1], p.gain[1], p.offset[1] )
      --}}}
      --{{{  do middle rows
      SEQ row = 1 FOR (num.packets-2)
        SEQ
          PRI PAR
            PAR
```

```
            in ? buffer[in.ptr]
            out ! buffer[out.ptr]
          ProcessRow( buffer[process.ptr], p.background[row],
                      p.gain[row], p.offset[row] )
        temp := out.ptr
        out.ptr := process.ptr
        process.ptr := in.ptr
        in.ptr := temp
    --}}}
    --{{{  process last row
    VAL i IS num.packets - 1 :
    PRI PAR
      out ! buffer[out.ptr]
      ProcessRow( buffer[process.ptr], p.background[i],
                  p.gain[i], p.offset[i] )
    --}}}
    --{{{  output last row
    out ! buffer[ process.ptr ]
    --}}}
:
--}}}
--{{{  CalibrationFrame
PROC CalibrationFrame ( CHAN OF ANY out, VAL REAL32 level,
                        [128][8] REAL32 Gain, Offset )

  --{{{  retype array to packet.length
  [num.packets][packet.length] REAL32  p.gain        RETYPES Gain       :
  [num.packets][packet.length] REAL32  p.offset      RETYPES Offset     :
  --}}}
  --{{{  variables
  INT out.ptr :
  [2][packet.length] INT buffer :
  PLACE buffer IN WORKSPACE :
  [packet.length] REAL32 b.row :
  [packet.length] INT t.row :
  --}}}
  SEQ
    out.ptr := 0
    --{{{  initialize
    VAL INT i.level RETYPES level :
    SEQ i = 0 FOR packet.length
      SEQ
        b.row[i] := 0.0 (REAL32)
        t.row[i] := i.level
    --}}}
    --{{{  process first row
    SEQ
      buffer[0] := t.row
      ProcessRow( buffer[0], b.row, p.gain[1], p.offset[1] )
    --}}}
    --{{{  do middle rows
    SEQ row = 1 FOR (num.packets-1)
      SEQ
        PRI PAR
          out ! buffer[out.ptr]
          SEQ
            buffer[1-out.ptr] := t.row
            ProcessRow( buffer[1-out.ptr], b.row,
                        p.gain[row], p.offset[row] )
        out.ptr := 1 - out.ptr
    --}}}
    --{{{  output last row
    out ! buffer[ out.ptr ]
    --}}}
:
--}}}
--{{{  SelectRow
```

```
PROC SelectRow ( [8] REAL32 dest, [128] REAL32 source )

  SEQ i = 0 FOR 8
    dest[i] := source[ (i*16) + position ]
:
--}}}
--{{{  variables
[max.frames][128][8] REAL32 Background :
[128][8] REAL32 Gain, Offset :

BYTE length :
[max.message] INT message :
command IS message[0] :
params IS [message FROM 1 FOR (max.message-1)] :
[] REAL32 r.params RETYPES params :
--}}}
SEQ
  --{{{  initialize last background frame
  SEQ i = 0 FOR 128
    SEQ j = 0 FOR 8
      Background[max.frames-1][i][j] := 0.0008234782 (REAL32)
  --}}}
  WHILE TRUE
    SEQ
      --{{{  get command and pass on
      fromPrev ? length::message
      IF
        position < 15
          toNext ! length::message
        TRUE
          SKIP
      --}}}
      CASE command
        --{{{  c.set.background
        c.set.background
          ProcessFrame( fromTarget, toSP, Background[ params[0] ],
                        Gain, Offset )
        --}}}
        --{{{  c.background.row
        c.background.row
          SelectRow( Background[ params[0] ][ params[1] ], [r.params FROM 2 FOR
128] )
        --}}}
        --{{{  c.gain.row
        c.gain.row
          SelectRow( Gain[ params[0] ], [r.params FROM 1 FOR 128] )
        --}}}
        --{{{  c.offset.row
        c.offset.row
          SelectRow( Offset[ params[0] ], [r.params FROM 1 FOR 128] )
        --}}}
        --{{{  c.global.scale
        c.global.scale
          g.scale := r.params[0]
        --}}}
        --{{{  c.test.background
        c.test.background
          SEQ
            SEQ i = 0 FOR 128
              SEQ j = 0 FOR 8
                VAL  col  IS  (j << 4) + position :
                SEQ
                  Gain[i][j] := 0.80008787 (REAL32) -
                                ((REAL32 ROUND col) / 254.3456 (REAL32))
                  Offset[i][j] := 0.0008723984 (REAL32) +
                                ((REAL32 ROUND i) * 19.789 (REAL32))
                  Background[max.frames-1][i][j] := 0.0008234782 (REAL32)
```

```
            --}}}
            --{{{  c.calibration.frame
            c.calibration.frame
              CalibrationFrame( toSP, r.params[0], Gain, Offset )
            --}}}
:
```

4.1.5. Controller.occ

```
PROC Controller ( CHAN OF ANY fromHost, toHost, fromGTSEI, toGTSEI,
                                fromBG, toBG, fromSP, toSP )

  PRI PAR
    --{{{  make processing a high priority process
    #INCLUDE "s_header.inc"
    --{{{  variables
    --{{{  command variables
    BYTE length :
    [max.message] INT message :
    command IS message[0] :
    params IS [message FROM 1 FOR (max.message-1)] :
    [] REAL32 r.params RETYPES params :
    --}}}

    [max.sim.frames] REAL32 frame.rate, frame.time, frame.range :
    [max.sim.frames] INT  ticks :
    [max.sim.frames][p.length] REAL32 position :

    INT frames.loaded, start, value :   -- temporary variables
    INT current.frame, increment :
    INT offset, col, row :
    BOOL test.mode :
    INT calibration.frame, num.cal.frames :
    INT shift.row, shift.col :
    [10] REAL32 calibration.level :
    [10] INT    sp.cal.level :

    VAL  seconds.per.tick  IS  1.0E-6(REAL32) :
    TIMER clock :

    --{{{  force some scalars in vector space
    [3] INT frame.array :
    sim.frame   IS frame.array[0] :
    first.frame IS frame.array[1] :
    last.frame  IS frame.array[2]:
    --}}}
    --}}}
    SEQ
      --{{{  initialize
      current.frame := max.frames - 1
      increment := 1
      test.mode := TRUE
      calibration.frame := 10
      shift.row := 0
      shift.col := 0
      --}}}
      WHILE TRUE
        SEQ
          --{{{  get command
          fromHost ? length::message
          --}}}
          --{{{  process command
          IF
            --{{{  GTSEI and Target commands
            (command >= 256) AND (command < 768)
              toGTSEI ! length::message
            --}}}
            --{{{  Background commands
            (command >= 768) AND (command < 1024)
              toBG ! length::message
            --}}}
            --{{{  Guidance commands
            (command >= 1280) AND (command < 1536)
```

```
              toSP ! length::message
            --}}}
            --{{{  c.read.graphics
            command = c.read.graphics
              INT bufLength :
              INT number.of.transfers :
              [maxGraphicBuffer]BYTE graphicsBuffer :
              SEQ
                toSP ! length::message
                fromSP ? number.of.transfers
                toHost ! number.of.transfers
                SEQ i = 0 FOR number.of.transfers
                  SEQ
                    fromSP ? bufLength::graphicsBuffer
                    toHost ! bufLength::graphicsBuffer
            --}}}
            --{{{  c.frame.start
            command = c.start.frame
              SEQ
                IF
                  params[0] < 0
                    SKIP
                  params[0] = 0
                    sim.frame := params[1]
                  TRUE
                    sim.frame := first.frame + params[1]
                --{{{  sim.frame := MAX( 0, MIN( last.frame, sim.frame ))
                IF
                  sim.frame < 0
                    sim.frame := 0
                  sim.frame > last.frame
                    sim.frame := last.frame
                  TRUE
                    SKIP
                --}}}
                increment := params[2]
                --calibration.frame := num.cal.frames
                test.mode := FALSE
            --}}}
            --{{{  c.run.single
            command = c.run.single
              SEQ
                IF
                  calibration.frame < num.cal.frames
                    --{{{  send calibration frame
                    SEQ
                      toBG ! BYTE 2; c.calibration.frame; calibration.level[
calibration.frame ]
                      toSP ! BYTE 9; c.sp.frame; calibration.frame;
                                     sp.cal.level[ calibration.frame ]; 0; 65535;
                                     0.0(REAL32); 0.0(REAL32); -1; 64.0(REAL32)
                      calibration.frame := calibration.frame + 1
                    --}}}
                  sim.frame < first.frame
                    --{{{  send next non-FPA frame
                    SEQ
                      toSP ! 12(BYTE); c.guidance.run; 0; frame.range[ sim.frame
];
                             frame.time[ sim.frame ]; 0; 0; position[ sim.frame ]
                      toSP ! 6(BYTE); c.display.info; 0; frame.range[ sim.frame ];
                             frame.time[ sim.frame ]; 0; 0

                      IF
                        test.mode
                          frame.time[ sim.frame ] := frame.time[ sim.frame ] +
(1.0(REAL32) /
                                                     frame.rate[ sim.frame ])
```

```
                    sim.frame < last.frame
                      sim.frame := sim.frame + increment
                    TRUE
                      SKIP
                --}}}
              TRUE
                --{{{  send next FPA frame
                SEQ
                  current.frame := sim.frame - first.frame

                  offset := ((row /\ 3) << 2) + (col /\ 3)
                  toGTSEI ! BYTE 2; c.set.crossbar; (col >> 2) /\ 15
                  toGTSEI ! BYTE 5; c.set.target; current.frame; offset;
(row>>2); (col>>2)
                  toBG ! BYTE 2; c.set.background; current.frame
                  toSP ! BYTE 15; c.sp.frame; -1; 0; 2500; 65535;
                                  frame.range[ sim.frame ]; frame.time[
sim.frame ];
                                  current.frame+1; frame.rate[ sim.frame ];
position[ sim.frame]
                  IF
                    test.mode
                      --{{{  update statistics
                      SEQ
                        frame.time[ sim.frame ] := frame.time[ sim.frame ] +
(1.0(REAL32) /
                                                   frame.rate[ sim.frame ])
                        frame.range[ sim.frame ] := frame.range[ sim.frame ] -
                                                    (10000.0(REAL32) /
frame.rate[ sim.frame ])
                      --}}}
                    sim.frame < last.frame
                      sim.frame := sim.frame + increment
                    TRUE
                      SKIP
                --}}}
            --{{{  process any guidance commands
            VAL  delay.ticks  IS  INT ROUND (0.05 (REAL32) / seconds.per.tick)
:
            INT time.now, interrupt.time :
            INT command :
            BOOL exit :
            SEQ
              clock ? time.now
              interrupt.time := time.now + delay.ticks

              exit := FALSE
              WHILE NOT exit
                PRI ALT
                  clock ? AFTER interrupt.time
                    exit := TRUE
                  fromSP ? command
                    --{{{  process command
                    CASE command
                      cc.shift.image
                        INT shift.col, shift.row :
                        SEQ
                          fromSP ? shift.col; shift.row
                          col := (col + shift.col) /\ 511
                          row := (row + shift.row) /\ 511
                      ELSE
                        SKIP
                    --}}}
          --}}}
        --}}}
        --{{{  c.run.continuous
        command = c.run.continuous
```

```
                VAL  delay.ticks IS INT ROUND( 5.0E-4(REAL32) / seconds.per.tick ) :
                INT last.start.time, next.start.time, interrupt.time :
                INT command :
                BOOL running, exit :
                SEQ
                  --{{{  check sending calibration frames
                  WHILE calibration.frame < num.cal.frames
                    --{{{  send calibration frame
                    SEQ
                      toBG ! BYTE 2; c.calibration.frame; calibration.level[
calibration.frame ]
                      toSP ! BYTE 9; c.sp.frame; calibration.frame;
                                     sp.cal.level[ calibration.frame ]; 0; 65535;
                                     0.0(REAL32); 0.0(REAL32); -1; 64.0(REAL32)
                      calibration.frame := calibration.frame + 1
                    --}}}
                  --}}}
                  --{{{  initialize
                  clock ? last.start.time
                  interrupt.time := last.start.time
                  next.start.time := interrupt.time + delay.ticks
                  --}}}
                  running := TRUE
                  WHILE running
                    SEQ
                      --{{{  send current frame
                      IF
                        sim.frame < first.frame
                          --{{{  send next non-FPA frame  ** this code should be
obsolete **
                          SEQ
                            --{{{  wait for correct time
                            INT current.time :
                            VAL  wait.ticks  IS  INT ROUND( 1.0E-4(REAL32) /
seconds.per.tick ) :
                            SEQ
                              clock ? current.time
                              IF
                                (next.start.time MINUS current.time) > wait.ticks
                                  clock ? AFTER next.start.time
                                TRUE
                                  SKIP
                            --}}}

                            toSP ! 12(BYTE); c.guidance.run; 0; frame.range[
sim.frame ];
                                   frame.time[ sim.frame ]; 0; 0; position[
sim.frame ]
                            toSP ! 6(BYTE); c.display.info; 0; frame.range[
sim.frame ];
                                   frame.time[ sim.frame ]; 0; 0
                          --}}}
                        TRUE
                          --{{{  send out FPA frame
                          SEQ
                            current.frame := sim.frame - first.frame

                            --{{{  send to SP and wait for response
                            -- this code has been added to handle the guidance
commands that
                            -- will occur when running with the PFP.  If no guidance
has
                            -- been selected, the shift values should return 0 and
work as before,
                            -- otherwise, the PFP will drive the simulation

                            SEQ
```

```
                        toSP ! BYTE 9; c.sp.frame; -1; 0; 2500; 65535;
                                       frame.range[ sim.frame ]; frame.time[
sim.frame ];
                                       current.frame+1; frame.rate[ sim.frame
]
                                       --position[ sim.frame ]

                      --}}}
                      --{{{  wait for response from SP  -- syncs to correct
time
                      fromSP ? command ; col; row
                      col := (col + shift.col) /\ 511
                      row := (row + shift.row) /\ 511
                      --}}}
                      offset := ((row /\ 3) << 2) + (col /\ 3)   -- uses
previous values


                      toGTSEI ! BYTE 2; c.set.crossbar; (col >> 2) /\ 15
                      toGTSEI ! BYTE 5; c.set.target; current.frame; offset;
(row>>2); (col>>2)

                      --{{{  wait for correct time
                      INT current.time :
                      VAL  wait.ticks  IS  INT ROUND( 1.0E-4(REAL32) /
seconds.per.tick ) :
                      SEQ
                        clock ? current.time
                        IF
                          (next.start.time MINUS current.time) > wait.ticks
                            SKIP
                            --clock ? AFTER next.start.time
                          TRUE
                            SKIP
                      --}}}

                      --{{{  old code for sending to the SP
                      --  toSP ! BYTE 15; c.sp.frame; -1; 0; 2500; 65535;
                      --                  frame.range[ sim.frame ]; frame.time[
sim.frame ];
                      --                  current.frame+1; frame.rate[
sim.frame ];
                      --                  position[ sim.frame ]
                      --}}}
                      toBG ! BYTE 2; c.set.background; current.frame

                    --}}}
                  --{{{  move to next frame
                  IF
                    test.mode
                      --{{{  update statistics
                      SEQ
                        frame.time[ sim.frame ] := frame.time[ sim.frame ] +
(1.0(REAL32) /
                                                   frame.rate[ sim.frame ])
                        frame.range[ sim.frame ] := frame.range[ sim.frame ] -
                                                   (10000.0(REAL32) /
frame.rate[ sim.frame ])
                      --}}}
                    sim.frame < last.frame
                      sim.frame := sim.frame + increment
                    TRUE
                      SKIP
                  --}}}
                  --{{{  update for next frame
                  last.start.time := next.start.time
                  --clock ? last.start.time
```

```
                    next.start.time := last.start.time PLUS ticks[ sim.frame ]
                    interrupt.time := next.start.time MINUS delay.ticks
                    --}}}
                    --}}}
                    exit := FALSE
                    WHILE NOT exit
                      PRI ALT
                        --clock ? AFTER interrupt.time
                        fromHost ? command
                          --{{{  process command
                          CASE command
                            cc.shift.image
                              INT temp.shift.col, temp.shift.row :
                              SEQ
                                fromHost ? temp.shift.col; temp.shift.row
                                --col := (col + shift.col) /\ 511
                                --row := (row + shift.row) /\ 511
                                shift.row := shift.row + temp.shift.row
                                shift.col := shift.col + temp.shift.col
                            cc.exit
                              SEQ
                                exit := TRUE
                                running := FALSE
                            ELSE
                              SKIP
                          --}}}
                        TRUE & SKIP
                          exit := TRUE
                        --fromSP ? command
                          --{{{  process command  ** this code should be obsolete
**
                          --CASE command
                          --  cc.shift.image
                          --    INT shift.col, shift.row :
                          --    SEQ
                          --      fromSP ? shift.col; shift.row
                          --      col := (col + shift.col) /\ 511
                          --      row := (row + shift.row) /\ 511
                          --  ELSE
                          --    SKIP
                          --}}}
                --}}}
                --{{{  c.frame.rate
                command = c.frame.rate
                  SEQ
                    start := params[0]
                    frames.loaded := params[1]
                    [frame.rate FROM start FOR frames.loaded] :=
                                              [r.params FROM 2 FOR frames.loaded]
                --}}}
                --{{{  c.frame.time
                command = c.frame.time
                  SEQ
                    start := params[0]
                    frames.loaded := params[1]
                    [frame.time FROM start FOR frames.loaded] :=
                                                    [r.params FROM 2 FOR
frames.loaded]
                --}}}
                --{{{  c.frame.range
                command = c.frame.range
                  SEQ
                    start := params[0]
                    frames.loaded := params[1]
                    [frame.range FROM start FOR frames.loaded] :=
                                                  [r.params FROM 2 FOR
frames.loaded]
```

```
--}}}
--{{{  c.sim.position
command = c.sim.position
  INT ptr :
  SEQ
    value := params[0]
    start := params[1]
    frames.loaded := params[2]

    ptr := 3
    SEQ i = start FOR frames.loaded
      SEQ
        position[i][value] := r.params[ptr]
        ptr := ptr + 1
--}}}
--{{{  c.sim.start.frames
command = c.sim.start.frames
  SEQ
    first.frame := params[0]
    last.frame  := params[1]

    IF
      (first.frame + 1) < last.frame
        SEQ
          SEQ i = 0 FOR last.frame
            ticks[i] := INT ROUND( (frame.time[i+1] - frame.time[i]) /
                                   seconds.per.tick )
          ticks[ last.frame ] := ticks[ last.frame-1 ]
      TRUE
        SKIP
--}}}
--{{{  c.test.controller
command = c.test.controller
  SEQ
    sim.frame := first.frame + (max.frames - 1)
    test.mode := TRUE
    row := 0
    col := 0
    ticks[ sim.frame ] := INT ROUND( ( 1.0(REAL32) / 64.0(REAL32) ) /
                                     seconds.per.tick )
    frame.range[ sim.frame ] := 100000.0 (REAL32)
    frame.time[ sim.frame ] := 0.0 (REAL32)
    frame.rate[ sim.frame ] := 64.0 (REAL32)
--}}}
--{{{  c.restart
command = c.restart
  SEQ
    calibration.frame := 0
    test.mode := FALSE
    sim.frame := 0
    row := 0
    col := 0
    shift.row := 0
    shift.col := 0
--}}}
--{{{  c.set.calibration
command = c.set.calibration
  SEQ
    num.cal.frames := params[0]
    [calibration.level FROM 0 FOR num.cal.frames] :=
              [r.params FROM 1 FOR num.cal.frames]
    [sp.cal.level FROM 0 FOR num.cal.frames] :=
              [params FROM 1+num.cal.frames FOR num.cal.frames]
--}}}
--{{{  else SKIP
TRUE
  SKIP
```

```
            --}}}
          --}}}
    --}}}
    SKIP
:
```

4.1.6. FirstBuffer.occ

```
PROC FirstBuffer ( CHAN OF ANY in, out, fromNext, toPrev,
                   VAL INT position, shift )

  --{{{  variables
  [2][64] INT input.buffer :
  INT count :
  --}}}
  --{{{  channels
  CHAN OF ANY synch0, synch1, internal :
  --}}}
  --{{{  Receiver
  PROC Receiver ( CHAN OF ANY in, out0, out1, [2][64] INT buffer )

    INT i :
    SEQ
      i := 0
      WHILE TRUE
        SEQ
          in ? buffer[i]
          out0 ! i
          out1 ! i
          i := 1 - i
  :
  --}}}
  --{{{  Sender
  PROC Sender ( CHAN OF ANY in, out, [2][64] INT buffer )

    INT i :
    SEQ
      WHILE TRUE
        SEQ
          in ? i
          out ! buffer[i]
  :
  --}}}
  --{{{  Extractor
  PROC Extractor ( CHAN OF ANY internal, in, out,
                   VAL INT count )

    --{{{  variables
    [2][64][2] BYTE buffer :
    INT output :
    --}}}
    SEQ
      internal ? buffer[0]
      output := 0
      WHILE TRUE
        SEQ
          SEQ i = 0 FOR count
            SEQ
              PAR
                out ! buffer[output]
                in ? buffer[ 1-output ]
              output := 1 - output
          PAR
            out ! buffer[output]
            internal ? buffer[1-output]
          output := 1 - output
  :
  --}}}
  --{{{  Formatter
  PROC Formatter ( CHAN OF ANY synch, out,
                   [2][64] INT input.buffer )
```

```
    --{{{  variables
    [2][64][4] BYTE b.in RETYPES input.buffer :
    [64][2] BYTE buffer :
    [64*2] BYTE buffer1 RETYPES buffer :
    INT in.ptr :
    --}}}
    SEQ
      WHILE TRUE
        SEQ
          --{{{  form message in buffer
          SEQ
            synch ? in.ptr

            source IS input.buffer[in.ptr] :
            INT p :
            SEQ
              p := 0
              SEQ i = 0 FOR 64
                INT store :
                SEQ
                  store := source[i] >> shift
                  --{{{  check for zeroing store
                  IF
                    store = 0
                      IF
                        source[i] <> 0
                          store := 1
                        TRUE
                          SKIP
                    TRUE
                      SKIP
                  --}}}
                  buffer1[p] := BYTE store
                  buffer1[p+1] := BYTE store
                  p := p + 2
          --}}}
          out ! buffer
  :
  --}}}
  SEQ
    IF
      position < 8
        count := 7 - position
      TRUE
        count := 15 - position
    PRI PAR
      PAR
        Receiver( in, synch0, synch1, input.buffer )
        Sender( synch0, out, input.buffer )
        Extractor( internal, fromNext, toPrev, count )
      Formatter( synch1, internal, input.buffer )
:
```

4.1.7. Formatter.occ

```
PROC Formatter ( CHAN OF ANY in, out )

  --{{{  constants
  VAL buffer.size IS 64*16 :
  --}}}
  --{{{  variables
  [2][buffer.size] BYTE input.buffer, output.buffer :
  [8] INT store.offset :
  --}}}
  --{{{  channels
  CHAN OF ANY synch0, synch1 :
  --}}}
  --{{{  Receiver
  PROC Receiver ( CHAN OF ANY in, out, [2][buffer.size] BYTE buffer )

    INT i :
    SEQ
      i := 0
      WHILE TRUE
        SEQ
          in ? buffer[i]
          out ! i
          i := 1 - i
  :
  --}}}
  --{{{  Formatter
  PROC Formatter ( CHAN OF ANY in, out,
                   [2][buffer.size] BYTE in.buffer, out.buffer )

    INT out.ptr, in.ptr :
    SEQ
      out.ptr := 0
      WHILE TRUE
        SEQ
          in ? in.ptr
          --{{{  format
          [8][64][2] BYTE inb RETYPES in.buffer[in.ptr] :
          [64][16] BYTE outb RETYPES out.buffer[out.ptr] :
          SEQ
            SEQ i = 0 FOR 8
              source IS inb[i] :
              VAL start  IS i << 1 :
              MOVE2D( source, 0, 0, outb, start, 0, 2, 64 )
          --}}}
          out ! out.ptr
          out.ptr := 1 - out.ptr
  :
  --}}}
  --{{{  Sender
  PROC Sender ( CHAN OF ANY in, out, [2][buffer.size] BYTE buffer )

    INT i :
    SEQ
      WHILE TRUE
        SEQ
          in ? i
          out ! buffer[i]
  :
  --}}}
  SEQ
    WHILE TRUE
      PRI PAR
        PAR
          Receiver( in, synch0, input.buffer )
```

```
        Sender( synch1, out, output.buffer )
      Formatter( synch0, synch1, input.buffer, output.buffer )
;
```

4.1.8. G_Line.occ

```
--{{{  SC line
--:::A  3 10
--{{{  line
--{{{  libraries
#INCLUDE "g_header.inc"
--}}}
--{{{  plot
PROC plot ( VAL [] INT window, [] BYTE screen,
            VAL INT x, y, VAL BYTE color )

  -- plots a single point on the screen
  -- makes sure the pixels are actually in the window
  VAL pixels.line IS window[ w.pixels.line ] :
  VAL size.x      IS window[ w.size.x ] :
  VAL size.y      IS window[ w.size.y ] :
  SEQ
    IF
      (x < 0) OR (y < 0) OR (x >= size.x) OR (y >= size.y)
        SKIP
      TRUE
        screen[ (y * pixels.line) + x ] := color
:
--}}}
--{{{  draw.line
PROC draw.line ( VAL [] INT window, [] BYTE screen,
                 VAL INT x1, y1, x2, y2,
                 VAL BYTE color )

  --{{{  clip.line
  PROC clip.line (VAL INT x1, y1, x2, y2, INT result, VAL []INT window)
    -- decides whether a line is totally on or off screen/window
    --{{{  codes
    VAL code.centre IS #00 :        -- 0000
    VAL code.left   IS #01 :        -- 0001
    VAL code.right  IS #02 :        -- 0010
    VAL code.bottom IS #04 :        -- 0100
    VAL code.top    IS #08 :        -- 1000
    --}}}
    INT code1, code2 :
    --{{{  PROC check
    PROC check (VAL INT x, y, INT code)
      VAL x.max IS window[ w.size.x ] :
      VAL y.max IS window[ w.size.y ] :
      SEQ
        IF
          --{{{  x.min <= x < x.max
          (x >= 0) AND (x < x.max)
            code := code.centre
          --}}}
          --{{{  x < x.min
          x < 0
            code := code.left
          --}}}
          --{{{  x > x.max
          TRUE --x >= x.max
            code := code.right
          --}}}
        IF
          -{{{  y.min <= y < y.max
          (y >= 0) AND (y < y.max)
            SKIP
          --}}}
          --{{{  y < y.min
          y < 0
```

```
          code := code \/ code.top
        --}}}
        --{{{  y >= y.max
        TRUE --y > y.max
          code := code \/ code.bottom
        --}}}
  :
  --}}}
  SEQ
    check (x1, y1, code1)
    check (x2, y2, code2)
    IF
      --{{{  line lies entirely within window
      (code1 \/ code2) = 0
        result := in.range
      --}}}
      --{{{  line lies entirely outside window
      (code1 /\ code2) <> 0
        result := not.inrange
      --}}}
      --{{{  partially in window perhaps
      TRUE
        result := part.inrange
      --}}}
:
--}}}
--{{{  slow.draw.line
PROC slow.draw.line ( VAL [] INT window, [] BYTE screen,
                      VAL INT x1, y1, x2, y2,
                      VAL BYTE color )
  -- uses Bresenham's integer algorithm to calculate plotting points
  -- calls plot to draw actual pixels on the screen
  VAL pixels.line IS window[w.pixels.line] :
  INT dx, dy :
  INT two.dx, two.dy :
  INT error :
  SEQ
    dx := x2 - x1
    dy := y2 - y1
    IF
      (dx <> 0) OR (dy <> 0)
        SEQ
          --{{{  a line to draw
          IF
            --{{{  dy = 0                -- horizontal line
            dy = 0
              SEQ i = x1 FOR dx + 1
                plot (window, screen, i, y1, color)
            --}}}
            --{{{  dx = 0                -- vertical line
            dx = 0
              SEQ
                IF
                  dy > 0
                    SEQ i = y1 FOR dy + 1
                      plot (window, screen, x1, i, color)
                  TRUE
                    SEQ i = y2 FOR (-dy) + 1
                      plot (window, screen, x1, i, color)
            --}}}
            --{{{  dx <> 0  dy <> 0     -- diagonal line
            TRUE
              INT x, y :
              INT delta.y :
              SEQ
                x := x1
                y := y1
```

```
two.dx := dx + dx
IF
  --{{{  dy > 0
  dy > 0
    SEQ
      two.dy := dy + dy
      IF
        --{{{  dy > dx
        dy > dx
          SEQ
            error := two.dx - dy
            --{{{  plot line
            SEQ i = 0 FOR dy + 1
              SEQ
                plot (window, screen, x, y, color )
                IF
                  error >= 0
                    SEQ
                      x := x + 1
                      error := error - two.dy
                  TRUE
                    SKIP
                y := y + 1
                error := error + two.dx
            --}}}
        --}}}
        --{{{  dy <= dx
        TRUE
          SEQ
            error := two.dy - dx
            --{{{  plot line
            SEQ i = 0 FOR dx + 1
              SEQ
                plot (window, screen, x, y, color )
                IF
                  error >= 0
                    SEQ
                      y := y + 1
                      error := error - two.dx
                  TRUE
                    SKIP
                x := x + 1
                error := error + two.dy
            --}}}
      --}}}
  --}}}
  --{{{  dy < 0
  TRUE
    SEQ
      dy := -dy
      two.dy := dy + dy
      IF
        --{{{  dy > dx
        dy > dx
          SEQ
            error := two.dx - dy
            --{{{  plot line
            SEQ i = 0 FOR dy + 1
              SEQ
                plot (window, screen, x, y, color)
                IF
                  error >= 0
                    SEQ
                      x := x + 1
                      error := error - two.dy
                  TRUE
                    SKIP
```

```
                                y := y - 1
                                error := error + two.dx
                            --}}}
                        --}}}
                        --{{{  dy <= dx
                        TRUE
                          SEQ
                            error := two.dy - dx
                            SEQ i = 0 FOR dx + 1
                              SEQ
                                plot (window, screen, x, y, color)
                                IF
                                  error >= 0
                                    SEQ
                                      y := y - 1
                                      error := error - two.dx
                                  TRUE
                                    SKIP
                                x := x + 1
                                error := error + two.dy
                        --}}}
                    --}}}
                --}}}
            --}}}
      TRUE
        plot (window, screen, x1, y1, color)
:
--}}}
--{{{  fast.draw.line
PROC fast.draw.line (VAL [] INT window, [] BYTE screen,
                     VAL INT x1, y1, x2, y2,
                     VAL BYTE  color)

  -- uses Bresenham's integer algorithm to calculate plotting points
  -- points are in increasing values of x
  -- only called when the line is known to be on screen / in window and
  -- the current pixel size is one
  INT dx, dy, two.dx, two.dy, delta.x, delta.y :
  INT error, pixel :
  VAL pixels.line IS window[ w.pixels.line ] :
  SEQ
    dx := x2 - x1               -- always zero or positive
    dy := y2 - y1
    pixel := (y1 * pixels.line) + x1
    IF
      (dx <> 0) OR (dy <> 0)
        SEQ
          --{{{  a line to draw
          IF
            --{{{  dy = 0               -- horizontal line
            dy = 0
              SEQ i = pixel FOR dx + 1
                screen[i] := color
            --}}}
            --{{{  dx = 0               -- vertical line
            dx = 0
              SEQ
                IF
                  dy > 0
                    SEQ i = 0 FOR dy + 1
                      SEQ
                        screen[pixel] := color
                        pixel := pixel + pixels.line
                  TRUE
                    SEQ i = 0 FOR (-dy) + 1
                      SEQ
                        screen[pixel] := color
```

```
                    pixel := pixel - pixels.line
              --}}}
              --{{{  dx <> 0 AND dy <> 0
              TRUE
                INT delta.y :
                SEQ
                  two.dx := dx + dx
                  IF
                    dy > 0
                      delta.y := pixels.line
                    TRUE
                      SEQ
                        dy := -dy
                        delta.y := -pixels.line
                  two.dy := dy + dy
                  IF
                    --{{{  dy > dx
                    dy > dx
                      SEQ
                        error := two.dx - dy
                        --{{{  plot line
                        SEQ i = 0 FOR dy + 1
                          SEQ
                            screen[pixel] := color
                            IF
                              error >= 0
                                SEQ
                                  pixel := pixel + 1
                                  error := error - two.dy
                              TRUE
                                SKIP
                            pixel := pixel + delta.y
                            error := error + two.dx
                        --}}}
                    --}}}
                    --{{{  dy <= dx
                    TRUE
                      SEQ
                        error := two.dy - dx
                        --{{{  plot line
                        SEQ i = 0 FOR dx + 1
                          SEQ
                            screen[pixel] := color
                            IF
                              error >= 0
                                SEQ
                                  pixel := pixel + delta.y
                                  error := error - two.dx
                              TRUE
                                SKIP
                            pixel := pixel + 1
                            error := error + two.dy
                        --}}}
                    --}}}
              --}}}
            --}}}
      TRUE
        screen[pixel] := color
:
--}}}
INT x3, y3, x4, y4 :
INT result :
SEQ
  --{{{  swap x1,y1 with x2,y2 if x1 > x2
  IF
    x1 > x2
      SEQ
```

```
            x3 := x2
            y3 := y2
            x4 := x1
            y4 := y1
        TRUE
          SEQ
            x3 := x1
            y3 := y1
            x4 := x2
            y4 := y2
      --}}}
      clip.line (x3, y3, x4, y4, result, window)
      IF
        (result = in.range)
          fast.draw.line (window, screen, x3, y3, x4, y4, color)
        (result = part.inrange) OR (result = in.range)
          slow.draw.line (window, screen, x3, y3, x4, y4, color)
        TRUE
          SKIP
:
--}}}
--{{{  draw.polyline
PROC draw.polyline ( VAL [] INT window, [] BYTE screen,
                     VAL [][2]INT points, VAL BYTE color)

  -- calls draw line to draw the lines
  INT x, y :
  SEQ
    x := points[0][0]
    y := points[0][1]
    SEQ i = 1 FOR (SIZE points) - 1
      VAL point IS points[i] :
      SEQ
        draw.line( window, screen, x, y, point[0], point[1], color )
        x := point[0]
        y := point[1]
:
--}}}
--{{{  draw.rectangle
PROC draw.rectangle ( VAL [] INT window, [] BYTE screen,
                      VAL [2][2]INT p, VAL BYTE color)

  -- calls draw line to draw the lines
  INT x, y :
  SEQ
    draw.line( window, screen, p[0][0], p[0][1], p[1][0], p[0][1], color )
    draw.line( window, screen, p[1][0], p[0][1], p[1][0], p[1][1], color )
    draw.line( window, screen, p[1][0], p[1][1], p[0][0], p[1][1], color )
    draw.line( window, screen, p[0][0], p[1][1], p[0][0], p[0][0], color )
:
--}}}
--}}}
--}}}
```

4.1.9. G_System.occ

```
--{{{  SC system
--:::A  3 10
--{{{  system
--{{{  libraries
#INCLUDE "crtc.inc"
#INCLUDE "g_header.inc"
--}}}
--{{{  set.colour
PROC set.colour ( CHAN OF CRTC message,
                  VAL INT channel, pixel, red, green, blue )
  -- set up a colour in the G170 colour look up table
  SEQ
    message ! crtc.color; INT16 channel; INT16 pixel;
                          INT16 red; INT16 green; INT16 blue
:
--}}}
--{{{  set.timing
PROC set.timing( CHAN OF CRTC message,
                 VAL INT width,height, line.frequency, frame.rate, pixel.clock,
                 VAL BOOL interlace )

  SEQ
    message ! crtc.init; INT16 width; INT16 height; INT32 line.frequency;
              INT16 frame.rate; INT32 pixel.clock; interlace
:
--}}}
--{{{  set.B408
PROC set.B408( VAL INT DS, IE, EM, OE, R )

  --{{{  system constants
  VAL bpw.shift IS 2 :
  VAL mint      IS MOSTNEG INT :

  VAL DisplayStart.address    IS (#00000000   >< mint) >> bpw.shift :
  VAL InterlaceEnable.address IS (#000C0000   >< mint) >> bpw.shift :
  VAL EventMode.address       IS (#00100000   >< mint) >> bpw.shift :
  VAL OutputEnable.address    IS (#00140000   >< mint) >> bpw.shift :
  VAL Ready.address           IS (#00040000   >< mint) >> bpw.shift :

  INT DisplayStart, InterlaceEnable, EventMode, OutputEnable, Ready :

  PLACE  DisplayStart      AT  DisplayStart.address    :
  PLACE  InterlaceEnable   AT  InterlaceEnable.address :
  PLACE  EventMode         AT  EventMode.address       :
  PLACE  OutputEnable      AT  OutputEnable.address    :
  PLACE  Ready             AT  Ready.address           :
  --}}}
  SEQ
    DisplayStart := DS
    InterlaceEnable := IE
    EventMode := EM
    OutputEnable := OE
    Ready := R
:
--}}}
--{{{  init.G170
PROC init.G170 (CHAN OF CRTC message, VAL INT channel, table)

  SEQ
    message ! crtc.initLUT; INT16 channel; INT16 table
:
--}}}
--{{{  clear.window
PROC clear.window (VAL [] INT window, [] BYTE screen)
```

```
  VAL size.x       IS  window[ w.size.x ] :
  VAL size.y       IS  window[ w.size.y ] :
  VAL pixels.line  IS  window[ w.pixels.line ] :
  VAL b.color      IS  BYTE window[ w.background.color ] :
  INT ptr :
  SEQ
    SEQ i = 0 FOR size.x
      screen[i] := b.color
    ptr := pixels.line
    SEQ i = 0 FOR size.y - 1
      SEQ
        [screen FROM ptr FOR size.x] := [screen FROM 0 FOR size.x]
        ptr := ptr + pixels.line
:
--}}}
--}}}
--}}}
```

4.1.10. G_Text.occ

```
--{{{  SC text
--:::A  3 10
--{{{  text
#INCLUDE "g_header.inc"
--{{{  FUNCTION GetINT
INT FUNCTION GetINT (VAL INT pointer, VAL [] INT table)
  INT return :
  VAL [] BYTE b.table RETYPES table :
  VALOF
    [4]BYTE return.b RETYPES return :
    SEQ
      return.b[0] := b.table[pointer]
      return.b[1] := b.table[pointer + 1]
      return.b[2] := b.table[pointer + 2]
      return.b[3] := b.table[pointer + 3]
    RESULT return
:
--}}}
--{{{  FUNCTION GetINT16
INT16 FUNCTION GetINT16 (VAL INT pointer, VAL [] INT table)
  INT16 return :
  VAL [] BYTE b.table RETYPES table :
  VALOF
    [2]BYTE return.b RETYPES return :
    SEQ
      return.b[0] := b.table[pointer]
      return.b[1] := b.table[pointer + 1]
    RESULT return
:
--}}}
--{{{  FUNCTION GetBYTE
BYTE FUNCTION GetBYTE (VAL INT pointer, VAL [] INT table)
  BYTE return :
  VAL [] BYTE b.table RETYPES table :
  VALOF
    SEQ
      return := b.table[pointer]
    RESULT return
:
--}}}
--{{{  get.font.spec
PROC get.font.spec ( VAL [] INT font, [fs.size] INT spec)

  SEQ
    spec[ fs.PixWidth   ] := INT (GetINT16 (dfPixWidth.p,  font))
    spec[ fs.PixHeight  ] := INT (GetINT16 (dfPixHeight.p, font))
    spec[ fs.FirstChar  ] := INT (GetBYTE  (dfFirstChar.p, font))
    spec[ fs.LastChar   ] := INT (GetBYTE  (dfLastChar.p,  font))
    spec[ fs.BitsOffset ] :=      GetINT   (dfBitsOffset.p,font)
:
--}}}
--{{{  scroll
PROC scroll ( VAL [] INT window, []BYTE screen,
              VAL INT jump.size )
  -- scrolls a screen or window by the required number of lines (jump.size)
  VAL size.x      IS  window[ w.size.x ] :
  VAL size.y      IS  window[ w.size.y ] :
  VAL pixels.line IS  window[ w.pixels.line ] :
  VAL b.color     IS  BYTE window[ w.background.color ] :
  INT p1, p2 :
  IF
    (jump.size > 0) AND (jump.size < size.y)
      --{{{  scroll screen
      SEQ
```

```
        p1 := 0
        p2 := pixels.line * jump.size
        SEQ i = 0 FOR (size.y - jump.size)
          SEQ
            [screen FROM p1 FOR size.x] := [screen FROM p2 FOR size.x]
            p1 := p1 + pixels.line
            p2 := p2 + pixels.line
        SEQ i = 0 FOR size.x
          screen[ p1 + i ] := b.color
        p2 := p1 + pixels.line
        SEQ i = 0 FOR (jump.size - 1)
          SEQ
            [screen FROM p2 FOR size.x] := [screen FROM p1 FOR size.x]
            p2 := p2 + pixels.line
      --}}}
    jump.size > 0
      --{{{  clear screen
      SEQ

        SEQ i = 0 FOR size.x
          screen[ i ] := b.color
        p2 := pixels.line
        SEQ i = 0 FOR (jump.size - 1)
          SEQ
            [screen FROM p2 FOR size.x] := [screen FROM 0 FOR size.x]
            p2 := p2 + pixels.line
      --}}}
    TRUE
      SKIP
:
--}}}
--{{{  draw.char  v2.0
PROC draw.char ( [] INT window, [] BYTE screen,
                 VAL BYTE char,
                 VAL [] INT font, VAL [fs.size] INT spec )

  --{{{  constants
  VAL mask IS 1 << 7 :
  pixels.line IS window[ w.pixels.line ] :
  size.x      IS window[ w.size.x      ] :
  size.y      IS window[ w.size.y      ] :
  cursor.x    IS window[ w.cursor.x    ] :
  cursor.y    IS window[ w.cursor.y    ] :

  VAL [] BYTE b.font RETYPES font :
  --}}}
  --{{{  variables
  INT bit, pixel :
  INT bitmask :
  INT char.width, offset, PixWidthBytes :
  INT char.spacing :
  INT character :
  --}}}
  --{{{  line feed
  PROC line.feed ( )

    SEQ
      cursor.y := cursor.y + spec[ fs.PixHeight ]
      IF
        (cursor.y + spec[ fs.PixHeight ]) < size.y
          SKIP
        TRUE
          INT scroll.lines :
          SEQ
            scroll.lines := (spec[ fs.PixHeight ] - (size.y - cursor.y)) + 1
            cursor.y := (size.y - spec[ fs.PixHeight ]) - 1
            scroll( window, screen, scroll.lines )
```

```
  :
  --}}}
  SEQ
    character := INT char
    IF
      char = '*n'
        line.feed ()
      char = '*c'
        --{{{  carriage return
        cursor.x := 0
        --}}}
      (character >= spec[ fs.FirstChar ]) AND (character <= spec[ fs.LastChar])
        SEQ
          character := character - spec[ fs.FirstChar ]
          --{{{  set font data
          IF
            spec[ fs.PixWidth ] <> 0                              -- Fixed Width
              SEQ
                PixWidthBytes  := (spec[ fs.PixWidth ] + 7) >> 3
                char.width     := spec[ fs.PixWidth ]
                offset         := (character * (PixWidthBytes * spec[ fs.PixHeight
]) +
                                   spec[ fs.BitsOffset ]
                char.spacing   := char.width
            TRUE                                                  -- Variable Width
              INT char.width.p, char.pointer.p :
              SEQ
                char.width.p   := CharTable.p + (character << 2)
                char.pointer.p := char.width.p + 2
                char.width     := INT(GetINT16(char.width.p, font))
                offset         := INT(GetINT16(char.pointer.p, font))
                PixWidthBytes  := (char.width + 7) >> 3
                char.spacing   := char.width + 1
          --}}}
          IF
            --{{{  char too big
            (char.width > size.x) OR (spec[ fs.PixHeight ] > size.y)
              SKIP
            --}}}
            --{{{  room to draw char
            BOOL delayed.crlf :
            TRUE
              SEQ
                delayed.crlf := FALSE
                IF
                  --{{{  room to draw whole char
                  ((cursor.x + char.spacing) < size.x) AND
                      ((cursor.y + spec[ fs.PixHeight ]) < size.y)
                    SKIP
                  --}}}
                  --{{{  room to draw but at end of line
                  ((cursor.x + char.spacing) = size.x) AND
                      ((cursor.y + spec[ fs.PixHeight ]) < size.y)
                    delayed.crlf := TRUE
                  --}}}
                  --{{{  we need carriage return - line feed
                  TRUE
                    SEQ
                      cursor.x := 0
                      line.feed ()
                  --}}}
                pixel := (cursor.y TIMES pixels.line) + cursor.x
                --{{{  plot foreground only
                VAL f.color IS BYTE window[ w.foreground.color ] :
                SEQ
                  SEQ i = 0 FOR spec[ fs.PixHeight ]
                    SEQ
```

```
                        --{{{  draw row
                        SEQ j = 0 FOR PixWidthBytes
                          SEQ
                            bitmask := mask
                            VAL this.byte IS INT b.font[ offset+((spec[fs.PixHeight]
TIMES j) + i) ] :
                            SEQ k = 0 FOR 8
                              SEQ
                                bit := this.byte /\ bitmask
                                IF
                                  --{{{  leave background as it is
                                  bit = 0
                                    SKIP
                                  --}}}
                                  --{{{  plot foreground bit
                                  TRUE
                                    screen[ pixel ] := f.color
                                  --}}}
                                pixel := pixel + 1
                                bitmask := bitmask >> 1
                        --}}}
                        pixel := (pixel - (PixWidthBytes<<3)) + pixels.line

                    cursor.x := cursor.x + char.spacing
                  --}}}
                  IF
                    delayed.crlf
                      --{{{  we need carriage return - line feed
                      SEQ
                        cursor.x := 0
                        line.feed ()
                      --}}}
                    TRUE
                      SKIP
              --}}}
        TRUE
          SKIP
:
--}}}
--{{{  write.string v2.0
PROC write.string ( [] INT window, [] BYTE screen,
                    VAL [] BYTE string, VAL [] INT font )

  [fs.size] INT spec :
  SEQ
    get.font.spec( font, spec )
    SEQ i = 0 FOR (SIZE string)
      draw.char( window, screen, string[i], font, spec )
:
--}}}
--{{{  string.width
PROC string.width ( VAL [] INT font, VAL [] BYTE string, INT width )

  [fs.size] INT spec :
  SEQ
    get.font.spec( font, spec )
    width := 0
    SEQ i = 0 FOR SIZE string
      --{{{  add width for character[i]
      INT character :
      SEQ
        character := INT string[i]
        IF
          (character >= spec[ fs.FirstChar ]) AND (character <= spec[ fs.LastChar]
)
            SEQ
              character := character - spec[ fs.FirstChar ]
```

```
              --{{{  determine width from font
              IF
                spec[ fs.PixWidth ] <> 0                                -- Fixed Width
                  width := width + spec[ fs.PixWidth ]
                TRUE                                                    -- Variable
Width
                  INT char.width.p, char.pointer.p :
                  SEQ
                    char.width.p   := CharTable.p + (character << 2)
                    width := (width + 1) + (INT(GetINT16(char.width.p, font)))
              --}}}
            TRUE
              SKIP
      --}}}
:
--}}}
--}}}
--}}}
```

4.1.11. GIF.occ

```
#INCLUDE "hostio.inc"
#USE "hostio.lib"

PROC Encode (CHAN OF SP fs, ts, VAL INT32 GIFFile,
             VAL INT MaxColumn, MaxRow, BitsPerPixel,
             VAL []INT Palette, VAL [][]INT Pixels)
  --{{{  GIF Encoder
  PROC Encoder (VAL [][]INT pixels, CHAN OF INT out,
                CHAN OF INT size, VAL INT bitsPerPixel)

    --{{{  putCode
    PROC putCode (CHAN OF INT out, VAL INT value)
      out ! value
    :
    --}}}

    VAL max.table.size IS (1 << 13) :

    --{{{  Clear
    PROC Clear (VAL INT bits.per.pixel, INT CodeSize, NextValidCode,
                MaxCode, [max.table.size] INT Child, Sibling)

      SEQ
        CodeSize := bits.per.pixel + 1
        NextValidCode :=(1 << bits.per.pixel) + 2
        MaxCode := 1 << (bits.per.pixel + 1)
        SEQ I = 0 FOR max.table.size
          SEQ
            Child [I] := 0
            Sibling [I] := 0
    :
    --}}}

    VAL pixel.rows IS (SIZE pixels) :
    [max.table.size] INT child, sibling, shade :
    INT codeSize, clearCode, endCode,
        minCode, maxCode, nextValidCode,
        color, son, parent, maxColor, pixCol, pixRow, pixelColumnsM1 :

    SEQ
      maxColor := (1 << bitsPerPixel) - 1
      color := 0

      --{{{  Initialize
      SEQ
        SEQ i = 0 FOR max.table.size
          SEQ
            child [i] := 0
            sibling [i] := 0
        codeSize := bitsPerPixel + 1
        clearCode := 1 << bitsPerPixel
        endCode := clearCode + 1
        nextValidCode := endCode + 1
        maxCode := clearCode << 1
      --}}}

      SEQ
        putCode (out, clearCode)
        size ! codeSize
        IF
          (0 < pixel.rows)
            SEQ
              pixelColumnsM1 := SIZE pixels [0]
              IF
```

```
        (0 < pixelColumnsM1)
          SEQ
            color := pixels [0][0]
            pixelColumnsM1 := pixelColumnsM1 -1
            IF
              (1 < pixelColumnsM1)
                SEQ
                  pixRow := 0
                  pixCol := 1
              TRUE
                SEQ
                  pixRow := 1
                  pixCol := 0
                  pixelColumnsM1 := (SIZE pixels [1]) - 1
        TRUE
          color := maxColor + 2
  TRUE
    color := maxColor + 2
parent := color
WHILE (color <= maxColor)
  --{{{  Compress
  SEQ
    IF
      (pixRow < pixel.rows)
        SEQ
          color := pixels [pixRow][pixCol]
          IF
            (pixCol < pixelColumnsM1)
              pixCol := pixCol + 1
            TRUE
              SEQ
                pixRow := pixRow + 1
                pixCol := 0
                pixelColumnsM1 := (SIZE pixels [pixRow]) - 1
      TRUE
        color := maxColor + 2
    son := child [parent]
    IF
      son <= 0
        --{{{  Parent has no son
        SEQ
          child [parent] := nextValidCode
          shade [nextValidCode] := color
          putCode (out, parent)
          size ! codeSize
          parent := color
          nextValidCode := nextValidCode + 1
        --}}}
      TRUE
        --{{{  Otherwise
        SEQ
          IF
            shade [son] = color
              parent := son  -- make new parent
            TRUE
              --{{{  son not right color
              BOOL looping :
              INT brother :
              SEQ
                brother := son
                looping := TRUE
                WHILE looping
                  SEQ
                    IF
                      sibling [brother] > 0
                        --{{{  Brother has brother
                        SEQ
```

```
                                brother := sibling [brother]
                                IF
                                  shade [brother] = color
                                    SEQ
                                      looping := FALSE
                                      parent := brother
                                  TRUE
                                    SKIP
                              --}}}
                            TRUE
                              --{{{  No brother, so create one
                              SEQ
                                looping := FALSE
                                sibling [brother] := nextValidCode
                                shade [nextValidCode] := color
                                putCode (out, parent)
                                size ! codeSize
                                parent := color
                                nextValidCode := nextValidCode + 1
                              --}}}
                      --}}}
                --}}}
              --{{{  Change code size if required
              IF
                nextValidCode > maxCode
                  IF
                    codeSize < 12
                      SEQ
                        codeSize := codeSize + 1
                        maxCode := maxCode << 1
                    TRUE
                      SEQ
                        putCode (out, clearCode)
                        size ! codeSize
                        Clear (bitsPerPixel, codeSize, nextValidCode,
                               maxCode, child, sibling)
                TRUE
                  SKIP
              --}}}
            --}}}
        putCode (out, endCode)
        size ! codeSize
:
--}}}

--{{{  so.fwrite.INT16
--Writes 2-byte integer, LSB first
PROC so.fwrite.INT16 (CHAN OF SP fs, ts, VAL INT32 StreamID,
                      VAL INT16 Value, BYTE Result)

  VAL msb IS #FF00 (INT16) :
  VAL lsb IS #00FF (INT16) :

  BYTE Result2 :

  SEQ
    so.fwrite.char (fs, ts, StreamID, BYTE (Value /\ lsb), Result)
    so.fwrite.char (fs, ts, StreamID, BYTE ((Value /\ msb) >> 8), Result2)
    Result := BYTE ((INT Result) \/ (INT Result2))
:
--}}}

--{{{  WriteBlock
PROC WriteBlock (CHAN OF SP fs, ts, VAL INT32 StreamID,
                 [255] BYTE Block, INT Length, BYTE Result)
  BYTE Result2 :
```

```
  SEQ
    so.fwrite.char (fs, ts, StreamID, BYTE Length, Result)
    SEQ I = 0 FOR Length
      SEQ
        so.fwrite.char (fs, ts, StreamID, Block [I], Result2)
        Result := BYTE ((INT Result) \/ (INT Result2))
    Length := 0
:
--}}}

--{{{  BlockByte
PROC BlockByte (CHAN OF SP fs, ts, VAL INT32 StreamID,
                [255] BYTE Block, INT Index, VAL BYTE Data, BYTE Result)

  SEQ
    Block [Index] := Data
    Index := Index + 1
    IF
      Index = 255
        WriteBlock (fs, ts, StreamID, Block, Index, Result)
      TRUE
        SKIP
:
--}}}

--{{{  Output
--Output process from Encoder
PROC Output (CHAN OF INT FromEncoder, Size, VAL INT32 GIFFile,
             VAL INT MaxColumn, MaxRow, BitsPerPixel,
             VAL []INT Palette                          )
  --{{{  Constants
  VAL byte.mask   IS #FF (INT32) :
  VAL size.of.int IS 4 :
  VAL colors      IS (1  << BitsPerPixel) :
  VAL max.byte    IS 40 :
  VAL depth       IS 2 :
  VAL max.gray    IS (1 << BitsPerPixel) :
  VAL ppw         IS ((size.of.int * 8) / BitsPerPixel) :
  VAL wpsl        IS (MaxColumn / ppw) :
  VAL red         IS 0 :
  VAL green       IS 1 :
  VAL blue        IS 2 :

  VAL gif.signature IS "GIF87a" :
  VAL global.color.map  IS #80 :
  VAL color.res         IS ((depth - 1) << 4) :
  VAL bits              IS (BitsPerPixel + 1) :
  VAL screen.height     IS (INT16 MaxRow) :
  VAL screen.left       IS 0 (INT16) :
  VAL screen.top        IS 0 (INT16) :
  VAL screen.width      IS (INT16 MaxColumn) :
  VAL screen.descriptor IS
           (BYTE ((global.color.map \/ color.res) \/
                                  (BitsPerPixel - 1))) :
  VAL background IS 0 (BYTE) :
  VAL endCode    IS ((1 << BitsPerPixel) + 1) :
  --}}}

  BYTE Result :
  INT CodeSize, OutByte, Shift, Value :
  INT32 Out :
  [3] BYTE ColorValue :
  [255] BYTE OutBlock :

  SEQ
    OutByte := 0
    --{{{  GIF Signature
```

```
so.fwrite.string (fs, ts, GIFFile, gif.signature, Result)
--}}}

--{{{  Screen Descriptor
so.fwrite.INT16 (f   ts, GIFFile, screen.width, Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.height, Result)
so.fwrite.char (fs, ts, GIFFile, screen.descriptor, Result)
so.fwrite.char (fs, ts, GIFFile, background, Result)
so.fwrite.char (fs, ts, GIFFile, 0 (BYTE), Result)
--}}}

--{{{  Global Color Map
VAL PaletteColors IS (SIZE Palette) :
SEQ I = 0 FOR colors
  SEQ
    IF
      (I < PaletteColors)
        SEQ
          ColorValue [blue] :=
            (BYTE ((INT32 Palette [I]) /\ byte.mask))
          ColorValue [green] :=
            (BYTE (((INT32 Palette [I]) >> 8) /\ byte.mask))
          ColorValue [red] :=
            (BYTE (((INT32 Palette [I]) >> 16) /\ byte.mask))
      TRUE
        SEQ
          ColorValue [blue] := 0 (BYTE)
          ColorValue [green] := 0 (BYTE)
          ColorValue [red] := 0 (BYTE)
    SEQ J = 0 FOR 3
      so.fwrite.char (fs, ts, GIFFile, ColorValue [J], Result)

--}}}

--{{{  Image Descriptor
so.fwrite.char (fs, ts, GIFFile, ',', Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.left, Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.top, Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.width, Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.height, Result)
so.fwrite.char (fs, ts, GIFFile, 0 (BYTE), Result)
--}}}

--{{{  Raster Data
--First byte is bits per image pixel
so.fwrite.char (fs, ts, GIFFile, BYTE BitsPerPixel, Result)

--{{{  Get first code
FromEncoder ? Value
Size ? CodeSize
Shift := CodeSize
Out := (INT32 Value)
--}}}

--{{{  Accept and package codes until end of image
WHILE (Value <> endCode)
  SEQ
    --{{{  Write any finished bytes
    WHILE (Shift > 8)
      SEQ
        BlockByte (fs, ts, GIFFile, OutBlock, OutByte,
                                  BYTE (Out /\ byte.mask), Result)
        Out := Out >> 8
        Shift := Shift - 8
    --}}}

    --{{{  Add next code
```

```
          FromEncoder ? Value
          Size ? CodeSize
          Out := Out \/ ((INT32 Value) << Shift)
          Shift := Shift + CodeSize
          --}}}
        --}}}

        --{{{  Output remaining codes
        WHILE (Shift > 0)
          SEQ
            BlockByte (fs, ts, GIFFile, OutBlock, OutByte,
                                  BYTE (Out /\ byte.mask), Result)
            Out := Out >> 8
            Shift := Shift - 8
        IF
          OutByte <> 0
            WriteBlock (fs, ts, GIFFile, OutBlock, OutByte, Result)
          TRUE
            SKIP

        --Raster data terminates with 0-byte block
        WriteBlock (fs, ts, GIFFile, OutBlock, OutByte, Result)
        --}}}
        --}}}

        --{{{  GIF Terminator
        so.fwrite.char (fs, ts, GIFFile, ';', Result)
        --}}}
    :
    --}}}

    CHAN OF INT FromEncoder :
    CHAN OF INT Size :


    PAR
      Encoder (Pixels, FromEncoder, Size, BitsPerPixel)
      Output (FromEncoder, Size, GIFFile,
              MaxColumn, MaxRow, BitsPerPixel, Palette)
:
```

4.1.12. GIF02.occ

```
#INCLUDE "hostio.inc"
#USE "hostio.lib"

PROC Encode (CHAN OF SP fs, ts, VAL INT32 GIFFile,
             VAL INT MaxColumn, MaxRow, BitsPerPixel,
             VAL []INT Palette, VAL [][]INT Pixels)
  --{{{  GIF Encoder
  PROC Encoder (CHAN OF INT in, out, CHAN OF INT size, VAL INT bitsPerPixel)

    --{{{  putCode
    PROC putCode (CHAN OF INT out, VAL INT value)
      out ! value
    :
    --}}}

    VAL max.table.size IS (1 << 13) :

    --{{{  Clear
    PROC Clear (VAL INT bits.per.pixel, INT CodeSize, NextValidCode,
                MaxCode, [max.table.size] INT Child, Sibling)

      SEQ
        CodeSize := bits.per.pixel + 1
        NextValidCode :=(1 << bits.per.pixel) + 2
        MaxCode := 1 << (bits.per.pixel + 1)
        SEQ I = 0 FOR max.table.size
          SEQ
            Child [I] := 0
            Sibling [I] := 0
    :
    --}}}

    [max.table.size] INT child, sibling, shade :
    INT codeSize, clearCode, endCode,
        minCode, maxCode, nextValidCode,
        color, son, parent, maxColor :

    SEQ
      maxColor := (1 << bitsPerPixel) - 1
      color := 0

      --{{{  Initialize
      SEQ
        SEQ i = 0 FOR max.table.size
          SEQ
            child [i] := 0
            sibling [i] := 0
        codeSize := bitsPerPixel + 1
        clearCode := 1 << bitsPerPixel
        endCode := clearCode + 1
        nextValidCode := endCode + 1
        maxCode := clearCode << 1
      --}}}

      SEQ
        putCode (out, clearCode)
        size ! codeSize
        in ? color
        parent := color
        WHILE (color <= maxColor)
          --{{{  Compress
          SEQ
            in ? color
            son := child [parent]
```

```
IF
  son <= 0
    --{{{  Parent has no son
    SEQ
      child [parent] := nextValidCode
      shade [nextValidCode] := color
      putCode (out, parent)
      size ! codeSize
      parent := color
      nextValidCode := nextValidCode + 1
    --}}}
  TRUE
    --{{{  Otherwise
    SEQ
      IF
        shade [son] = color
          parent := son  -- make new parent
        TRUE
          --{{{  son not right color
          BOOL looping :
          INT brother :
          SEQ
            brother := son
            looping := TRUE
            WHILE looping
              SEQ
                IF
                  sibling [brother] > 0
                    --{{{  Brother has brother
                    SEQ
                      brother := sibling [brother]
                      IF
                        shade [brother] = color
                          SEQ
                            looping := FALSE
                            parent := brother
                        TRUE
                          SKIP
                    --}}}
                  TRUE
                    --{{{  No brother, so create one
                    SEQ
                      looping := FALSE
                      sibling [brother] := nextValidCode
                      shade [nextValidCode] := color
                      putCode (out, parent)
                      size ! codeSize
                      parent := color
                      nextValidCode := nextValidCode + 1
                    --}}}
          --}}}
    --}}}
--{{{  Change code size if required
IF
  nextValidCode > maxCode
    IF
      codeSize < 12
        SEQ
          codeSize := codeSize + 1
          maxCode := maxCode << 1
      TRUE
        SEQ
          putCode (out, clearCode)
          size ! codeSize
          Clear (bitsPerPixel, codeSize, nextValidCode,
                 maxCode, child, sibling)
  TRUE
```

```
              SKIP
          --}}}
        --}}}
    putCode (out, endCode)
    size ! codeSize
:
--}}}

--{{{  so.fwrite.INT16
--Writes 2-byte integer, LSB first
PROC so.fwrite.INT16 (CHAN OF SP fs, ts, VAL INT32 StreamID,
                      VAL INT16 Value, BYTE Result)

  VAL msb IS #FF00 (INT16) :
  VAL lsb IS #00FF (INT16) :

  BYTE Result2 :

  SEQ
    so.fwrite.char (fs, ts, StreamID, BYTE (Value /\ lsb), Result)
    so.fwrite.char (fs, ts, StreamID, BYTE ((Value /\ msb) >> 8), Result2)
    Result := BYTE ((INT Result) \/ (INT Result2))
:
--}}}

--{{{  WriteBlock
PROC WriteBlock (CHAN OF SP fs, ts, VAL INT32 StreamID,
                 [255] BYTE Block, INT Length, BYTE Result)
  BYTE Result2 :

  SEQ
    so.fwrite.char (fs, ts, StreamID, BYTE Length, Result)
    SEQ I = 0 FOR Length
      SEQ
        so.fwrite.char (fs, ts, StreamID, Block [I], Result2)
        Result := BYTE ((INT Result) \/ (INT Result2))
    Length := 0
:
--}}}

--{{{  BlockByte
PROC BlockByte (CHAN OF SP fs, ts, VAL INT32 StreamID,
                [255] BYTE Block, INT Index, VAL BYTE Data, BYTE Result)

  SEQ
    Block [Index] := Data
    Index := Index + 1
    IF
      Index = 255
        WriteBlock (fs, ts, StreamID, Block, Index, Result)
      TRUE
        SKIP
:
--}}}

--{{{  Input
--Input process for Encoder
PROC Input (CHAN OF INT ToEncoder, VAL [][]INT Pixels, VAL INT End)
  SEQ
    SEQ I = 0 FOR (SIZE Pixels)
      SEQ J = 0 FOR (SIZE Pixels [I])
        ToEncoder ! Pixels [I][J]
    ToEncoder ! End
:
--}}}

--{{{  Output
```

```
--Output process from Encoder
PROC Output (CHAN OF INT FromEncoder, Size, VAL INT32 GIFFile,
             VAL INT MaxColumn, MaxRow, BitsPerPixel,
             VAL []INT Palette                          )
  --{{{  Constants
  VAL byte.mask   IS #FF (INT32) :
  VAL size.of.int IS 4 :
  VAL colors      IS (1  << BitsPerPixel) :
  VAL max.byte    IS 40 :
  VAL depth       IS 2 :
  VAL max.gray    IS (1 << BitsPerPixel) :
  VAL ppw         IS ((size.of.int * 8) / BitsPerPixel) :
  VAL wpsl        IS (MaxColumn / ppw) :
  VAL red         IS 0 :
  VAL green       IS 1 :
  VAL blue        IS 2 :

  VAL gif.signature IS "GIF87a" :
  VAL global.color.map  IS #80 :
  VAL color.res         IS ((depth - 1) << 4) :
  VAL bits              IS (BitsPerPixel + 1) :
  VAL screen.height     IS (INT16 MaxRow) :
  VAL screen.left       IS 0 (INT16) :
  VAL screen.top        IS 0 (INT16) :
  VAL screen.width      IS (INT16 MaxColumn) :
  VAL screen.descriptor IS
           (BYTE ((global.color.map \/ color.res) \/
                                (BitsPerPixel - 1))) :
  VAL background IS 0 (BYTE) :
  VAL endCode    IS ((1 << BitsPerPixel) + 1) :
  --}}}

  BYTE Result :
  INT CodeSize, OutByte, Shift, Value :
  INT32 Out :
  [3] BYTE ColorValue :
  [255] BYTE OutBlock :

  SEQ
    OutByte := 0
    --{{{  GIF Signature
    so.fwrite.string (fs, ts, GIFFile, gif.signature, Result)
    --}}}

    --{{{  Screen Descriptor
    so.fwrite.INT16 (fs, ts, GIFFile, screen.width, Result)
    so.fwrite.INT16 (fs, ts, GIFFile, screen.height, Result)
    so.fwrite.char (fs, ts, GIFFile, screen.descriptor, Result)
    so.fwrite.char (fs, ts, GIFFile, background, Result)
    so.fwrite.char (fs, ts, GIFFile, 0 (BYTE), Result)
    --}}}

    --{{{  Global Color Map
    VAL PaletteColors IS (SIZE Palette) :
    SEQ I = 0 FOR colors
      SEQ
        IF
          (I < PaletteColors)
            SEQ
              ColorValue [blue] :=
                (BYTE ((INT32 Palette [I]) /\ byte.mask))
              ColorValue [green] :=
                (BYTE (((INT32 Palette [I]) >> 8) /\ byte.mask))
              ColorValue [red] :=
                (BYTE (((INT32 Palette [I]) >> 16) /\ byte.mask))
          TRUE
            SEQ
```

```
          ColorValue [blue] := 0 (BYTE)
          ColorValue [green] := 0 (BYTE)
          ColorValue [red] := 0 (BYTE)
    SEQ J = 0 FOR 3
      so.fwrite.char (fs, ts, GIFFile, ColorValue [J], Result)

--}}}

--{{{  Image Descriptor
so.fwrite.char (fs, ts, GIFFile, ',', Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.left, Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.top, Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.width, Result)
so.fwrite.INT16 (fs, ts, GIFFile, screen.height, Result)
so.fwrite.char (fs, ts, GIFFile, 0 (BYTE), Result)
--}}}

--{{{  Raster Data
--First byte is bits per image pixel
so.fwrite.char (fs, ts, GIFFile, BYTE BitsPerPixel, Result)

--{{{  Get first code
FromEncoder ? Value
Size ? CodeSize
Shift := CodeSize
Out := (INT32 Value)
--}}}

--{{{  Accept and package codes until end of image
WHILE (Value <> endCode)
  SEQ
    --{{{  Write any finished bytes
    WHILE (Shift > 8)
      SEQ
        BlockByte (fs, ts, GIFFile, OutBlock, OutByte,
                                BYTE (Out /\ byte.mask), Result)
        Out := Out >> 8
        Shift := Shift - 8
    --}}}

    --{{{  Add next code
    FromEncoder ? Value
    Size ? CodeSize
    Out := Out \/ ((INT32 Value) << Shift)
    Shift := Shift + CodeSize
    --}}}
--}}}

--{{{  Output remaining codes
WHILE (Shift > 0)
  SEQ
    BlockByte (fs, ts, GIFFile, OutBlock, OutByte,
                            BYTE (Out /\ byte.mask), Result)
    Out := Out >> 8
    Shift := Shift - 8
IF
  OutByte <> 0
    WriteBlock (fs, ts, GIFFile, OutBlock, Out yte, Result)
  TRUE
    SKIP

--Raster data terminates with 0-byte block
WriteBlock (fs, ts, GIFFile, OutBlock, OutByte, Result)
--}}}
--}}}

--{{{  GIF Terminator
```

```
      so.fwrite.char (fs, ts, GIFFile, ';', Result)
      --}}}
  :
  --}}}

  VAL end IS ((1 << BitsPerPixel) + 1) :

  CHAN OF INT ToEncoder, FromEncoder :
  CHAN OF INT Size :


  PAR
    Input (ToEncoder, Pixels, end)
    Encoder (ToEncoder, FromEncoder, Size, BitsPerPixel)
    Output (FromEncoder, Size, GIFFile,
            MaxColumn, MaxRow, BitsPerPixel, Palette)
:
```

4.1.13. GTSEI.occ

```
PROC GTSEI ( CHAN OF ANY  fromController, toController, fromTarget, toTarget,
                          toCrossbar0, toCrossbar1 )

  #INCLUDE "s_header.inc"
  --{{{  Table
  VAL Table IS [ [  0,  4 ],
                 [  2,  5 ],
                 [  1,  6 ],
                 [  7,  3 ],
                 [ 29, 31 ],
                 [ 30, 28 ],
                 [ 24, 25 ],
                 [ 27, 26 ],
                 [ 17, 19 ],
                 [ 23, 22 ],
                 [ 21, 16 ],
                 [ 20, 18 ],
                 [ 10,  8 ],
                 [ 13,  9 ],
                 [ 14, 12 ],
                 [ 11, 15 ] ] :
  --}}}
  --{{{  variables
  BYTE synch :
  BOOL target.wait :
  [16][3] BYTE Set0, Set1 :
  INT Current.Selection :
  INT Selection :
  PLACE Selection AT  #800 :

  BYTE length :
  [max.message] INT32 message :
  command IS message[0] :
  params IS [message FROM 1 FOR (max.message-1)] :
  --}}}
  --{{{  DetermineSetting
  PROC DetermineSetting ( [16][3] BYTE Set0, Set1, VAL INT offset )

    SEQ
      SEQ i = 0 FOR 16
        VAL connection IS BYTE Table[ ((i + offset) /\ 15) ][ 0 ]  :
        SEQ
          Set0[i][1] := connection
          Set1[i][2] := connection
  :
  --}}}
  SEQ
    --{{{  initialize
    SEQ i = 0 FOR 16
      SEQ
        Set0[i][0] := 0 (BYTE)
        Set0[i][1] := BYTE Table[i][0]
        Set0[i][2] := BYTE Table[i][1]
        Set1[i][0] := 0 (BYTE)
        Set1[i][1] := BYTE Table[i][1]
        Set1[i][2] := BYTE Table[i][0]

    toCrossbar0 ! 4(BYTE); Set0; 3(BYTE)
    toCrossbar1 ! 4(BYTE); Set1; 3(BYTE)
    --}}}
    target.wait := FALSE
    WHILE TRUE
      SEQ
        fromController ? length::message
```

```
CASE INT command
  --{{{  c.set.crossbar
  c.set.crossbar
    DetermineSetting( Set0, Set1, INT params[0] )
  --}}}
  --{{{  c.set.target
  c.set.target
    SEQ
      IF
        target.wait
          fromTarget ? synch
        TRUE
          SKIP
      PAR
        toCrossbar0 ! 4(BYTE); Set0; 3(BYTE)
        toCrossbar1 ! 4(BYTE); Set1; 3(BYTE)
      toTarget ! length::message
      target.wait := TRUE
  --}}}
  --{{{  c.target.row
  c.target.row
    SEQ
      IF
        target.wait
          fromTarget ? synch
        TRUE
          SKIP
      target.wait := FALSE
      toTarget ! length::message
  --}}}
:
```

4.1.14. GTSPI.occ

```
PROC GTSPI (CHAN OF ANY in1, in2)
  --{{{  external memory and registers
  [16384]INT frame.buffer :
  PORT OF INT mclock.data :
  PORT OF INT mclock.control :
  PORT OF INT hclock.active :
  PORT OF INT hclock.blanking :
  PORT OF INT vclock.active :
  PORT OF INT vclock.blanking :
  PORT OF INT master.register :
  PORT OF INT control.register :
  --}}}
  --{{{  placements
  VAL base.address        IS #0800 :
  PLACE mclock.data       AT base.address :
  PLACE mclock.control    AT base.address + 1:
  PLACE hclock.active     AT base.address + 2 :
  PLACE hclock.blanking   AT base.address + 3 :
  PLACE vclock.active     AT base.address + 4 :
  PLACE vclock.blanking   AT base.address + 5 :
  PLACE master.register   AT base.address + 6 :
  PLACE control.register  AT base.address + 7 :
  PLACE frame.buffer      AT #4000 :
  --}}}
  VAL numRows IS 128 :
  VAL numCols IS 128 :

  --{{{  PROC talk.to.host
  PROC talk.to.host (CHAN OF ANY from.host)
    INT selection, scale:
    INT numCols :
    INT numRows :
    SEQ
      from.host ? selection ; scale
      --{{{  CASE selection
      CASE selection
        1
          mclock.data ! scale
        2
          SEQ
            hclock.active ! scale
            numCols := scale+1
        3
          hclock.blanking ! scale
        4
          SEQ
            vclock.active ! scale
            numRows := scale+1
        5
          vclock.blanking ! scale
        6
          SEQ i = 0 FOR 16384
            frame.buffer[i] := scale
        7
          INT row, col :
          SEQ
            from.host ? row; col
            frame.buffer[col + (row * numCols)] := scale
        8
          control.register ! scale   -- reset control is bit 0
        9
          mclock.control ! scale     -- clock enable  is bit 0
        ELSE
          SKIP
```

```
    --}}}
:
--}}}
--{{{  PROC reset ()
PROC reset ()
  TIMER clock :
  INT now :
  SEQ
    control.register ! 0   --reset
    clock ? now
    clock ? AFTER now PLUS 5
    control.register ! 1   -- clear the reset condition
:
--}}}

--{{{  variables
[2][64]INT buffer :
TIMER clock :
INT sync, out.frame, in.frame :
BOOL first.frame :
CHAN OF INT EndOfFrame :
PLACE EndOfFrame AT #08 :
INT last.frame.time :
CHAN OF ANY internal :
--}}}
--{{{  constants
VAL offset0 IS 0   :
VAL offset1 IS 16  :
VAL offset2 IS 32  :
VAL offset3 IS 48  :
VAL offset4 IS 64  :
VAL offset5 IS 80  :
VAL offset6 IS 96  :
VAL offset7 IS 112 :
--}}}
PRI PAR
  --{{{  handle frames
  SEQ
    --{{{  initialize
    SEQ
      reset ()
      hclock.active   ! numCols - 1
      hclock.blanking ! 1
      vclock.active   ! numRows - 1
      vclock.blanking ! 1
      mclock.data     ! 0    -- main clock divider
      mclock.control  ! 0    -- disable clock
      master.register ! 1    -- upper frame buffer
      SEQ i = 0 FOR 16384
        frame.buffer[i] := 0
      master.register ! 0    -- lower frame buffer
      SEQ i = 0 FOR 16384
        frame.buffer[i] := 0
      reset ()

      first.frame := TRUE
      in.frame := 0
      out.frame := 0
    --}}}
    --{{{  read calibration frames
    SEQ i = 0 FOR 2
      SEQ j = 0 FOR 16
        --SEQ k = 0 FOR 9
        SEQ k = 0 FOR 16
          --{{{  input
          PAR
            in1 ? buffer[0]
```

```
            in2 ? buffer[1]
          --}}}
      --}}}
      WHILE TRUE
        INT base1, base2 :
        SEQ
          base1 := 0
          base2 := 8
          SEQ i = 0 FOR 127
            SEQ
              PAR
                SEQ
                  --{{{  in1
                  in1 ? [frame.buffer FROM base1 + offset0 FOR 8]
                  in1 ? [frame.buffer FROM base1 + offset1 FOR 8]
                  in1 ? [frame.buffer FROM base1 + offset2 FOR 8]
                  in1 ? [frame.buffer FROM base1 + offset3 FOR 8]
                  in1 ? [frame.buffer FROM base1 + offset4 FOR 8]
                  in1 ? [frame.buffer FROM base1 + offset5 FOR 8]
                  in1 ? [frame.buffer FROM base1 + offset6 FOR 8]
                  in1 ? [frame.buffer FROM base1 + offset7 FOR 8]
                  --}}}
                SEQ
                  --{{{  in2
                  in2 ? [frame.buffer FROM base2 + offset0 FOR 8]
                  in2 ? [frame.buffer FROM base2 + offset1 FOR 8]
                  in2 ? [frame.buffer FROM base2 + offset2 FOR 8]
                  in2 ? [frame.buffer FROM base2 + offset3 FOR 8]
                  in2 ? [frame.buffer FROM base2 + offset4 FOR 8]
                  in2 ? [frame.buffer FROM base2 + offset5 FOR 8]
                  in2 ? [frame.buffer FROM base2 + offset6 FOR 8]
                  [8]INT buff :
                  SEQ
                    --in2 ? [frame.buffer FROM base2 + offset7 FOR 8]
                    in2 ? buff
                    [frame.buffer FROM base2 + offset7 FOR 7] := [buff FROM 0 FOR
7]
                  --}}}
                mclock.control ! 1 -- enable clock
                base1 := base1 + 128
                base2 := base2 + 128
            --{{{  throwaway last line
            PAR
              in1 ? buffer[0]
              in2 ? buffer[1]
            --}}}
            --IF
            --  first.frame
            --    first.frame := FALSE
            --  TRUE
            --    --EndOfFrame ? sync
            --    --clock ? AFTER (last.frame.time PLUS 400)
            --internal ! 1
            --out.frame := in.frame
            --in.frame := 1 - in.frame
            --master.register ! in.frame \/ (out.frame << 1)
      --}}}
      --{{{  handle syncs
      INT start :
      INT last.frame.time :
      VAL frame.time IS 390 :
      SEQ
        internal ? start
        clock ? last.frame.time
        WHILE TRUE
          SEQ
            last.frame.time := last.frame.time PLUS frame.time
```

```
          clock ? AFTER last.frame.time
          PRI ALT
            internal ? start
              SKIP
            TRUE & SKIP
              SKIP
    --}}}
:
```

4.1.15. GTSPI2.occ

```
PROC GTSPI (CHAN OF ANY in1, in2)
  --{{{  external memory and registers
  [16384]INT frame.buffer :
  PORT OF INT mclock.data :
  PORT OF INT mclock.control :
  PORT OF INT hclock.active :
  PORT OF INT hclock.blanking :
  PORT OF INT vclock.active :
  PORT OF INT vclock.blanking :
  PORT OF INT master.register :
  PORT OF INT control.register :
  --}}}
  --{{{  placements
  VAL base.address       IS #0800 :
  PLACE mclock.data      AT base.address :
  PLACE mclock.control   AT base.address + 1:
  PLACE hclock.active    AT base.address + 2 :
  PLACE hclock.blanking  AT base.address + 3 :
  PLACE vclock.active    AT base.address + 4 :
  PLACE vclock.blanking  AT base.address + 5 :
  PLACE master.register  AT base.address + 6 :
  PLACE control.register AT base.address + 7 :
  PLACE frame.buffer     AT #4000 :
  --}}}
  VAL numRows IS 128 :
  VAL numCols IS 128 :

  --{{{  PROC talk.to.host
  PROC talk.to.host (CHAN OF ANY from.host)
    INT selection, scale:
    INT numCols :
    INT numRows :
    SEQ
      from.host ? selection ; scale
      --{{{  CASE selection
      CASE selection
        1
          mclock.data ! scale
        2
          SEQ
            hclock.active ! scale
            numCols := scale+1
        3
          hclock.blanking ! scale
        4
          SEQ
            vclock.active ! scale
            numRows := scale+1
        5
          vclock.blanking ! scale
        6
          SEQ i = 0 FOR 16384
            frame.buffer[i] := scale
        7
          INT row, col :
          SEQ
            from.host ? row; col
            frame.buffer[col + (row * numCols)] := scale
        8
          control.register ! scale   -- reset control is bit 0
        9
          mclock.control ! scale     -- clock enable  is bit 0
        ELSE
          SKIP
```

```
    --}}}
:
--}}}
--{{{  PROC reset ()
PROC reset ()
  TIMER clock :
  INT now :
  SEQ
    control.register ! 0   --reset
    clock ? now
    clock ? AFTER now PLUS 1
    control.register ! 1   -- clear the reset condition
:
--}}}

TIMER clock :
[8][8]INT buffer1, buffer2 :
SEQ
  --{{{  initialize
  SEQ
    reset ()
    hclock.active   ! numCols - 1
    hclock.blanking ! 1
    vclock.active   ! numRows - 1
    vclock.blanking ! 1
    mclock.data     ! 0  -- main clock divider
    mclock.control ! 0  -- disable clock
    SEQ i = 0 FOR 16384
      frame.buffer[i] := 0
    reset ()
  --}}}
  --{{{  read calibration frames
  SEQ i = 0 FOR 2
    SEQ j = 0 FOR 16
      SEQ k = 0 FOR 8
        --{{{  input
        PAR
          in1 ? buffer1
          in2 ? buffer2
        --}}}
  --}}}

  WHILE TRUE
    INT base1, base2 :
    SEQ
      base1 := 0
      base2 := 8
      SEQ i = 0 FOR 16
        SEQ
          --{{{  handle sixteen sets of blocks
          SEQ j = 0 FOR 8
            SEQ
              --{{{  handle 8 blocks per set
              VAL offset1 IS j :
              SEQ
                --{{{  input
                PAR
                  in1 ? buffer1
                  in2 ? buffer2
                --}}}
                --{{{  write into memory
                SEQ k = 0 FOR 8
                  VAL offset2 IS k TIMES 128 :
                  SEQ l = 0 FOR 8
                    VAL offset3 IS l TIMES 16 :
                    IF
                      (i = 15) AND (k = 7)  -- last row
```

```
                        SKIP
                      TRUE
                        INT store1, store2 :
                        SEQ
                          store1 := buffer1[k][l] /\ #007F
                          store2 := buffer2[k][l] /\ #007F
                          frame.buffer[(base1 + offset3) + (offset1 + offset2)]
:= store1
                          IF
                            (j = 7) AND (l = 7)  -- last column
                              SKIP
                            TRUE
                              frame.buffer[(base2 + offset3) +
                                           (offset1 + offset2)] := store2
                --}}}
              --}}}
            --}}}
            --{{{  increment pointers
            base1 := base1 + (8 * 128)
            base2 := base2 + (8 * 128)
            mclock.control ! 1 -- enable clock
            --}}}
:
```

4.1.16. Guidance.occ

```
PROC Guidance ( CHAN OF ANY fromSP, toSP,
                            fromXBar, toXBar )

  --{{{  libraries
  #INCLUDE "s_header.inc"
  --}}}
  --{{{  constants
  VAL min.time IS 0.009 (REAL32) :
  --}}}
  --{{{  PROC test.setup
  PROC test.setup (CHAN OF ANY from.master, to.master)
    --{{{  constants
    --}}}
    INT command :
    REAL32 time, shift.x, shift.y:
    INT last.transfer.time :
    BOOL first.transfer :
    TIMER clock :
    REAL32 delta.x , delta.y :
    INT count :
    WHILE TRUE
      SEQ
        time    := 115.0 (REAL32)
        shift.x := (-50.0 (REAL32))
        shift.y := (50.0 (REAL32))
        delta.x := (0.05 (REAL32))
        delta.y := (-0.05  (REAL32))
        count := 0
        first.transfer := TRUE
        from.master ? command
        WHILE command = c.guidance.run
          --{{{  run simulation
          SEQ
            IF
              first.transfer
                first.transfer := FALSE
              TRUE
                clock ? AFTER (last.transfer.time PLUS 16)
            to.master ! time ; shift.x ; shift.y
            clock ? last.transfer.time
            from.master ? command
            time := time + 0.001 (REAL32)
            shift.x := shift.x + delta.x
            shift.y := shift.y + delta.y
            count := count + 1
            IF
              count = 2000
                SEQ
                  count := 0
                  delta.x := (-delta.x)
                  delta.y := (-delta.y)
              TRUE
                SKIP
          --}}}
  :
  --}}}
  CHAN OF ANY from.master, to.master :
  PAR
    test.setup (from.master, to.master)
    --{{{  master process
    BYTE length :
    [255]INT command.line :
    INT guidance.mode :
    SEQ
```

```
guidance.mode := gm.none
WHILE TRUE
  SEQ
    fromSP ? length::command.line
    CASE command.line[0]
      --{{{  set mode
      c.guidance.set.mode
        guidance.mode := command.line[1]
      --}}}
      --{{{  initialize
      c.guidance.initialize
        SEQ
          CASE guidance.mode
            gm.internal
              from.master ! c.guidance.initialize
            gm.external
              PAR
                toXBar ! c.guidance.initialize
                from.master ! c.guidance.initialize
            ELSE
              SKIP
      --}}}
      --{{{  run
      c.guidance.run
        --{{{  abbreviations and variables
        --FPA          IS command.line[1] :
        range        IS command.line[1] :
        time         IS command.line[2] :
        --centroid.x  IS command.line[4] :
        --centroid.y  IS command.line[5] :
        --seeker.int  IS [command.line FROM 6 FOR 3] :
        --target.int  IS [command.line FROM 9 FOR 3] :

        --[3]REAL32 seeker.xyz RETYPES seeker.int :
        --[3]REAL32 target.xyz RETYPES target.int :
        REAL32 r.time        RETYPES time :

        REAL32 pfp.time :
        REAL32 shift.x.r, shift.y.r :
        INT    shift.x,   shift.y :
        --}}}
        SEQ
          CASE guidance.mode
            gm.internal
              --{{{  from test proc
              SEQ
                from.master ! c.guidance.run
                to.master ? pfp.time; shift.x.r; shift.y.r
                WHILE (pfp.time < r.time)
                  SEQ
                    from.master ! c.guidance.run
                    to.master ? pfp.time ; shift.x.r ; shift.y.r
              --}}}
            gm.external
              --{{{  from PFP
              SEQ
                toXBar   ! c.guidance.run
                fromXBar ? pfp.time ; shift.x.r ; shift.y.r
                WHILE (pfp.time < r.time)
                  SEQ
                    toXBar   ! c.guidance.run
                    fromXBar ? pfp.time ; shift.x.r ; shift.y.r
              --}}}
            ELSE
              SEQ
                shift.x.r := 0.0 (REAL32)
                shift.y.r := 0.0 (REAL32)
```

```
                --{{{  time is okay now, send back the shift commands
                --{{{  convert pixel and fraction to sub-pixel
                shift.x := INT TRUNC (shift.x.r * (-4.0 (REAL32)))
                shift.y := INT TRUNC (shift.y.r * 4.0 (REAL32))
                --{{{  limit shift.x
                IF
                  shift.x > 240
                    shift.x := 240
                  shift.x < (-240)
                    shift.x := (-240)
                  TRUE
                    SKIP
                --}}}
                --{{{  limit shift.y
                IF
                  shift.y > 255
                    shift.y := 255
                  shift.y < (-255)
                    shift.y := (-255)
                  TRUE
                    SKIP
                --}}}
                --}}}
                toSP ! cc.shift.image; INT shift.x; INT shift.y
                --}}}
            --}}}
    --}}}
:
```

4.1.17. HostSeeker.occ

```
PROC HostSeeker (CHAN OF ANY fromSeeker, toSeeker )
  --{{{  libraries
  #INCLUDE "s_header.inc"
  #INCLUDE "hostio.inc"
  #USE "hostio.lib"
  --}}}
  --{{{  link definitions
  VAL  link0out   IS  0 :
  VAL  link1out   IS  1 :
  VAL  link2out   IS  2 :
  VAL  link3out   IS  3 :
  VAL  link0in    IS  4 :
  VAL  link1in    IS  5 :
  VAL  link2in    IS  6 :
  VAL  link3in    IS  7 :
  --}}}
  --{{{  channels
  CHAN OF SP fs, ts :
  PLACE fs AT link0in  :
  PLACE ts AT link0out :
  --}}}
  --{{{  constants
  VAL esc IS 27 :
  VAL max.screen.width  IS 640 :
  VAL max.screen.height IS 480 :
  --}}}
  --{{{  utility procs
  --{{{  goto.xy
  PROC goto.xy (CHAN OF SP fs, ts, VAL INT x, y)
    VAL esc IS 27 (BYTE) :
    SEQ
      so.write.string (fs, ts, [esc, '['])
      so.write.int (fs, ts, y+1, 0)
      so.write.char (fs, ts, ';')
      so.write.int (fs, ts, x+1, 0)
      so.write.char (fs, ts, 'H')
  :
  --}}}
  --{{{  clear.eos
  PROC clear.eos (CHAN OF SP fs, ts)
    VAL esc IS 27 (BYTE) :
    SEQ
      so.write.string (fs, ts, [esc, '[', 'J'])
  :
  --}}}
  --}}}
  --{{{  SC Encode
  #USE "gif02.c8h"
  --{{{F gif02.occ
  --:::F GIF02.OCC
  --}}}
  --}}}
  --{{{  SC loader
  #USE "loader.c8h"
  --{{{F loader.occ
  --:::F LOADER.OCC
  --}}}
  --}}}
  --{{{  SC runSeeker
  #USE "runseekr.c8h"
  --{{{F runSeekr.occ
  --:::F RUNSEEKR.OCC
  --}}}
  --}}}
```

```
--{{{  spectrum
PROC spectrum ( [256]INT palette )

  PROC set.colour (VAL INT index, r, g, b)
    SEQ
      palette[index] := (r << 16) \/ ((g << 8) \/ b)
  :
  SEQ
    SEQ i = 0 FOR 64                        -- blue to red scale for 1 to 63
      set.colour( i, i, 0, 31-(i>>1) )
    SEQ i = 0 FOR 64                        -- adding green and blue
      set.colour( 64+i, 63, i, i )          --    for 64 to 127

    SEQ i = 128 FOR 128                     -- green for 128-255
      set.colour( i, 0, 63, 0 )
    set.colour( 0, 0, 0, 0 )                -- black for 0
    set.colour( 128, 30, 30, 30 )           -- grey for 128
:
--}}}
--{{{  main menu variables
BOOL dont.exit   :
BYTE key, result :
--}}}
SEQ
  dont.exit := TRUE
  WHILE dont.exit
    SEQ
      --{{{  Main Menu
      goto.xy( fs, ts, 0, 0 )
      clear.eos( fs, ts )
      so.write.string( fs, ts, "Main Seeker Menu*c*n" )
      so.write.string( fs, ts, "----------------*c*n*n" )
      so.write.string( fs, ts, "*'Esc*' key to exit program.*c*n*n" )
      so.write.string( fs, ts, " (c)  capture screen image*c*n" )
      so.write.string( fs, ts, " (l)  load new data*c*n" )
      so.write.string( fs, ts, " (r)  run seeker*c*n" )
      so.write.nl( fs, ts )

      so.getkey( fs, ts, key, result )
      --}}}
      CASE key
        --{{{  c - capture screen
        'C', 'c'
          [max.screen.width]BYTE screen.buffer :
          [max.screen.height][max.screen.width]INT screen :
          [256]INT palette :
          INT screen.height, screen.width :
          SEQ
            --{{{  header
            goto.xy( fs, ts, 0, 0 )
            clear.eos( fs, ts )
            so.write.string( fs, ts, "Capture Screen Image*c*n" )
            so.write.string( fs, ts, "--------------------*c*n*n" )
            --}}}
            --{{{  get image
            spectrum(palette)

            --{{{  track display
            so.write.string( fs, ts, "Sending command to track display...*c*n" )
            toSeeker ! 2 (BYTE); c.read.graphics ; track.display
            fromSeeker ? screen.height
            SEQ i = 0 FOR screen.height
              SEQ
                so.write.int (fs, ts, i, 0)
                so.write.char (fs,ts, '*c')
                fromSeeker ? screen.width::screen.buffer
                SEQ j = 0 FOR screen.width
```

```
                    screen[i][j] := (INT screen.buffer[j])
                so.write.nl (fs, ts)
                --}}}
                --{{{  image display 0
                so.write.string( fs, ts, "Sending command to image display 0...*c*n"
)
                toSeeker ! 2 (BYTE); c.read.graphics ; image.display.0
                fromSeeker ? screen.height
                SEQ i = 0 FOR screen.height
                  SEQ
                    so.write.int (fs, ts, i, 0)
                    so.write.char (fs,ts, '*c')
                    fromSeeker ? screen.width::screen.buffer
                    SEQ j = 0 FOR screen.width
                      screen[i][j] := screen[i][j] \/ (INT screen.buffer[j])
                so.write.nl (fs, ts)
                --}}}
                --{{{  image display 1
                so.write.string( fs, ts, "Sending command to image display 1...*c*n"
)
                toSeeker ! 2 (BYTE); c.read.graphics ; image.display.1
                fromSeeker ? screen.height
                SEQ i = 0 FOR screen.height
                  SEQ
                    so.write.int (fs, ts, i, 0)
                    so.write.char (fs,ts, '*c')
                    fromSeeker ? screen.width::screen.buffer
                    SEQ j = 0 FOR screen.width
                      screen[i][j] := screen[i][j] \/ (INT screen.buffer[j])
                so.write.nl (fs, ts)
                --}}}
                --}}}
                --{{{  run gif encoder
                INT32 streamid :
                BYTE result :
                SEQ
                  so.open (fs, ts, "seeker.gif", spt.binary, spm.output,
                           streamid, result)
                  Encode (fs, ts, streamid, screen.width, screen.height,
                          8, palette, screen)
                --}}}
            --}}}
            --{{{  l - load new data
            'L', 'l'
              loader (fs, ts, fromSeeker, toSeeker)
            --}}}
            --{{{  r - run seeker
            'R', 'r'
              runSeeker (fs, ts, fromSeeker, toSeeker)
            --}}}
            --{{{  escape
            (BYTE esc)
              dont.exit := FALSE
            --}}}
            --{{{  else skip
            ELSE
              SKIP
            --}}}
    so.exit( fs, ts, 0 (INT32) )
:
```

4.1.18. HostStub.occ

```
PROC HostStub (CHAN OF ANY from.emulator, to.emulator)
  SKIP
:
```

4.1.19. ImageDisplay.occ

```
PROC ImageDisplay ( CHAN OF ANY Image0, Image1,
                                fromPrev, toPrev, fromNext, toNext,
                    VAL INT position, FRAMES )

  --{{{  libraries
  #INCLUDE  "crtc.inc"
  #INCLUDE  "g_header.inc"
  #INCLUDE  "s_header.inc"

  #USE  "convert.lib"
  #USE  "graphics.lib"
  --}}}
  --{{{  place system variables
  [(20*65536)+1280] BYTE screen.map :
  PLACE screen.map AT screen.int.address :

  INT DisplayStart :
  PLACE DisplayStart AT DisplayStart.address :

  INT EventMode :
  PLACE EventMode AT EventMode.address :

  INT SysReady :
  PLACE SysReady AT (#00080000  >< (MOSTNEG INT)) >> 2 :

  INT Ready :
  PLACE Ready AT Ready.address :
  --}}}
  --{{{  FrameReceiver
  PROC FrameReceiver ( CHAN OF ANY in0, in1,
                       [128][1280] BYTE frame,
                       VAL INT count0, count1 )

    --{{{  MOVE
    PROC MOVE( [][] BYTE source, VAL INT s.x, s.y,
               [][] BYTE dest,   VAL INT d.x, d.y, l.x, l.y )

      SEQ i = 0 FOR l.y
        [dest[d.y+i] FROM d.x FOR l.x] := [source[s.y+i] FROM s.x FOR l.x]
    :
    --}}}
    [128][40][32] BYTE s RETYPES frame :
    [2][8][16] BYTE buffer0 :
    PLACE buffer0 IN WORKSPACE :
    [2][8][16] BYTE buffer1 :
    PLACE buffer1 IN WORKSPACE :
    SEQ
      --{{{  get first lines
      PAR
        in0 ? buffer0[0]
        in1 ? buffer1[0]
      --}}}
      --{{{  get lines and place on display
      SEQ i = 0 FOR 127
        VAL input   IS (i+1)/\1 :
        VAL display IS i/\1 :
        si IS s[i] :
        b0 IS buffer0[ display ] :
        b1 IS buffer1[ display ] :
        PAR
          in0 ? buffer0[input]
          --{{{  place on display
          SEQ
            MOVE2D( b0, 0, 0, si,  0,  0, 16, 8 )
```

```
          MOVE2D( b0, 0, 0, si,  0, 20, 16, 8 )
          MOVE2D( b1, 0, 0, si, 16,  0, 16, 8 )
          MOVE2D( b1, 0, 0, si, 16, 20, 16, 8 )
        --}}}
        in1 ? buffer1[input]
    --}}}
    --{{{  place last lines on display
    si IS s[127] :
    b0 IS buffer0[ 1 ] :
    b1 IS buffer1[ 1 ] :
    SEQ
      MOVE2D( b0, 0, 0, si,  0,  0, 16, 8 )
      MOVE2D( b0, 0, 0, si,  0, 20, 16, 8 )
      MOVE2D( b1, 0, 0, si, 16,  0, 16, 8 )
      MOVE2D( b1, 0, 0, si, 16, 20, 16, 8 )
    --}}}
:
--}}}
--{{{  place Event channel
CHAN OF ANY Event :
PLACE Event AT 8 :
--}}}
--{{{  set up multiple screens
VAL screen.offset IS  [ #00000, #50000, #A0000, #F0000 ] :

VAL screen.address IS [ #00000, #14000, #28000, #3C000 ] :
--}}}
--{{{  EventProc
PROC EventProc ( CHAN OF ANY Event, in )

  INT synch, address :
  WHILE TRUE
    SEQ
      in ? address
      Ready := 1
      Event ? synch
      DisplayStart := address
      Ready := 0
:
--}}}
--{{{  Buffer
PROC Buffer ( CHAN OF ANY in, out )

  INT temp :
  SEQ
    WHILE TRUE
      SEQ
        in ? temp
        out ! temp
:
--}}}
--{{{  SetNewScreen
PROC SetNewScreen ( CHAN OF ANY in, VAL INT screen address )

  INT synch :
  SEQ
    Ready := 1
    in ? synch
    DisplayStart := screen.address
    SEQ i = 0 FOR 100
      SKIP
    Ready := 0
:
--}}}
--{{{  constants
VAL  screen.width   IS  640 :
VAL  screen.height  IS  480 :
```

```
  VAL  screen.size    IS  screen.width * screen.height :
  --}}}
  --{{{  variables
  CHAN OF ANY synch, synch1 :
  INT temp, load :
  [w.length] INT window :

  INT start.time, end.time :
  TIMER clock :

  BYTE length :
  [256]INT message :
  --{{{  x.offset
  VAL offset IS [ 32, 352 ] :
  VAL x.offset IS offset[ position ] :
  --}}}
  --}}}
  SEQ
    --{{{  initialize
    set.B408( 0, 0, 0, 0, 0 )
    window := [ 0, 640*480, 640, 0, 0, 640, 480, 255, 0, 0, 0 ]

    [] INT int.screen RETYPES screen.map :
    SEQ i = 0 FOR (20*65536)/4
      int.screen[i] := 0

    set.B408( 0, 0, 0, 1, 0 )

    load := 0
    --}}}
    PRI PAR
      PAR
        EventProc( Event, synch1  )
        Buffer( synch, synch1 )
        --{{{  read display info
        command IS message[0] :
        who     IS message[1] :
        WHILE TRUE
          SEQ
            fromPrev ? length::message
            IF
              command = c.read.graphics
                CASE who
                  image.display.0  -- this processor
                    --{{{
                    screen IS [screen.map FROM screen.offset[load] FOR screen.size
] :
                    [screen.height][screen.width] BYTE s2 RETYPES screen :
                    SEQ
                      toPrev ! screen.height
                      SEQ i = 0 FOR screen.height
                        toPrev ! screen.width::s2[i]
                    --}}}
                  ELSE
                    --{{{  image.display 1
                    INT number.of.transfers :
                    INT width :
                    [maxGraphicBuffer]BYTE graphicsBuffer :
                    SEQ
                      message[1] := message[1] - 1   -- decrement and send on
                      toNext   ! length::message
                      fromNext ? number.of.transfers
                      toPrev   ! number.of.transfers
                      SEQ i = 0 FOR number.of.transfers
                        SEQ
                          fromNext ? width::graphicsBuffer
                          toPrev     ! width::graphicsBuffer
```

```
                --}}}
          TRUE
            SKIP
  --}}}
--{{{  get display
SEQ
  WHILE TRUE
    VAL start IS  screen.offset[load] + ((112 * screen.width) + x.offset) :
    VAL size  IS  256 * screen.width :
    screen1 IS [screen.map FROM start FOR size ] :
    [128][screen.width*2] BYTE screen RETYPES screen1 :
    SEQ
      FrameReceiver( Image0, Image1, screen, 16, 4 )
      synch ! screen.address[load]
      load := (load + 1) /\ 3
--}}}
:
```

4.1.20. Loader.occ

```
--{{{  libraries
#INCLUDE "s_header.inc"
#INCLUDE "hostio.inc"
#USE "hostio.lib"
#USE "convert.lib"
--}}}
PROC loader (CHAN OF SP fs, ts, CHAN OF ANY from.seeker, to.seeker)

  --{{{  constants
  VAL esc IS 27 :

  VAL c.cal.frames IS 2 :
  VAL c.background IS 0 :
  VAL c.foreground IS 1 :
  VAL c.row.data IS 44 :

  VAL max.rows   IS 128 :
  VAL max.cols   IS 128 :
  VAL max.t.cols IS 512 :
  VAL max.fpa.frames IS max.frames :
  VAL max.buff.size  IS 128 :
  VAL sub.pixel.x IS 4 :
  VAL sub.pixel.y IS 4 :


  --}}}
  --{{{  global variables
  INT num.frames, num.sim.frames :
  INT nncols, nnrows :
  BOOL fpa.values, sim.values :

  [max.fpa.frames]REAL32 frame.rate, fpa.time, fpa.range :
  [6][max.fpa.frames]REAL32 fpa.position :

  [max.sim.frames]REAL32 sim.time, sim.range :
  [6][max.sim.frames]REAL32 sim.position :

  --}}}
  --{{{  channels
  VAL link.in.3  IS 7 :
  VAL link.out.3 IS 3 :

  CHAN OF ANY from.vax, to.vax :
  PLACE from.vax AT link.in.3  :
  PLACE to.vax   AT link.out.3 :
  --}}}
  --{{{  utility procs
  --{{{  goto.xy
  PROC goto.xy (CHAN OF SP fs, ts, VAL INT x, y)
    VAL esc IS 27 (BYTE) :
    SEQ
      so.write.string (fs, ts, [esc, '['])
      so.write.int (fs, ts, y+1, 0)
      so.write.char (fs, ts, ';')
      so.write.int (fs, ts, x+1, 0)
      so.write.char (fs, ts, 'H')
  :
  --}}}
  --{{{  clear.eos
  PROC clear.eos (CHAN OF SP fs, ts)
    VAL esc IS 27 (BYTE) :
    SEQ
      so.write.string (fs, ts, [esc, '[', 'J'])
  :
```

```
--}}}
--{{{  PROC indexed.file.name
PROC indexed.file.name ([]BYTE new.name, INT length,
                        VAL []BYTE base, VAL INT index,
                        VAL INT field.width, VAL []BYTE extension)
  INT temp :
  [8]BYTE index.string :
  SEQ
    length := SIZE (base)
    [new.name FROM 0 FOR length] := base
    INTTOSTRING (temp, index.string, index)
    SEQ i = 0 FOR field.width - temp
      SEQ
        new.name[length] := '0'
        length := length + 1
    [new.name FROM length FOR temp] := [index.string FROM 0 FOR temp]
    length := length + temp
    temp := SIZE (extension)
    [new.name FROM length FOR temp] := extension
    length := length + temp

:
--}}}
--}}}
--{{{  procs
--{{{  proc reverse.bytes ([4]BYTE)
PROC reverse.bytes ([4]BYTE block)
  [4]BYTE n.block :
  SEQ
    n.block := block
    block[0] := n.block[3]
    block[1] := n.block[2]
    block[2] := n.block[1]
    block[3] := n.block[0]
:
--}}}

--{{{  proc get.INT
PROC get.INT (CHAN OF SP fs, ts, VAL INT32 streamid, INT value)
  [4]BYTE block RETYPES value :
  INT length :
  SEQ
    so.read (fs, ts, streamid, length, block)
    reverse.bytes (block)
:
--}}}
--{{{  proc get.BYTE
PROC get.BYTE (CHAN OF SP fs, ts, VAL INT32 streamid, BYTE value)
  [1]BYTE block RETYPES value :
  INT length :
  SEQ
    so.read (fs, ts, streamid, length, block)
:
--}}}
--{{{  proc get.REAL32
PROC get.REAL32 (CHAN OF SP fs, ts, VAL INT32 streamid, REAL32 value)
  [4]BYTE block RETYPES value :
  INT length :
  SEQ
    so.read (fs, ts, streamid, length, block)
    reverse.bytes (block)
:
--}}}
--{{{  proc get.REAL32.vector
PROC get.REAL32.vector (CHAN OF SP fs, ts, VAL INT32 streamid, []REAL32 value)
  []BYTE block RETYPES value :
  INT length :
```

```
    BYTE temp :
    SEQ
      so.read (fs, ts, streamid, length, block)
      SEQ i = 0 FOR length / 4
        --{{{  reverse ordering
        section IS [block FROM (i TIMES 4) FOR 4] :
        SEQ
          reverse.bytes (section)
        --}}}
:
--}}}
--{{{  proc vax.filter
PROC vax.filter (CHAN OF ANY from.filter, to.filter, from.vax,
                 VAL BOOL dataFromTape)
  VAL buffer.size IS 16384 :
  VAL max.record  IS 4097 :
  BOOL continue, waiting.flag, full :
  INT need, count, start, end :
  BYTE count.byte :
  [buffer.size]BYTE buffer :
  SEQ
    continue := TRUE
    waiting.flag := FALSE
    start := 0
    end := 0
    full := FALSE
    IF
      dataFromTape
        --{{{  then use sophisticated buffer
        WHILE continue
          PRI ALT
            to.filter ? need
              --{{{
              IF
                need = 0
                  continue := FALSE
                TRUE
                  --{{{
                  IF
                    (end - start) >= need
                      SEQ
                        from.filter ! [buffer FROM start FOR need]
                        start := start + need
                        IF
                          start = end
                            SEQ
                              start := 0
                              end := 0
                          TRUE
                            SKIP
                    TRUE
                      waiting.flag := TRUE

                  --}}}
              --}}}
            (NOT full) & from.vax ? count.byte
              --{{{
              SEQ
                IF
                  (count.byte <> (BYTE #5E))
                    SEQ
                      --{{{  get record
                      count := (INT count.byte) /\ #0F
                      SEQ i = 0 FOR 3
                        SEQ
                          from.vax ? count.byte
                          count := (count * 10) + ((INT count.byte) /\ #0F)
```

```
                        count := count - 4
                        from.vax ? [buffer FROM end FOR count]
                        end := end + count
                        IF
                          waiting.flag AND ((end - start) >= need)
                            --{{{
                            SEQ
                              from.filter ! [buffer FROM start FOR need]
                              start := start + need
                              IF
                                start = end
                                  SEQ
                                    start := 0
                                    end := 0
                                TRUE
                                  SKIP
                              waiting.flag := FALSE

                            --}}}
                          TRUE
                            SKIP
                        --}}}
                    TRUE
                      SKIP
                  full := end > (buffer.size - max.record)
                --}}}
              (waiting.flag AND full) & SKIP
                --{{{
                [max.record]BYTE temp :
                INT length :
                SEQ
                  length := end - start
                  [temp FROM 0 FOR length] := [buffer FROM start FOR length]
                  [buffer FROM 0 FOR length] := [temp FROM 0 FOR length]
                  start := 0
                  end := length
                  full := FALSE
                --}}}
          --}}}
        TRUE
          --{{{
          WHILE continue
            SEQ
              to.filter ? need
              IF
                need = 0
                  continue := FALSE
                TRUE
                  SEQ
                    from.vax ? [buffer FROM 0 FOR need]
                    from.filter ! [buffer FROM 0 FOR need]
          --}}}
:
--}}}
--{{{  PROC fixVaxFloat
PROC fixVaxFloat (VAL REAL32 bad, REAL32 good)
  SEQ
    VAL [4]BYTE twiddle.dee RETYPES bad :
    [4]BYTE twiddle.dum RETYPES good :
    SEQ
      twiddle.dum[0] := twiddle.dee[2]
      twiddle.dum[1] := twiddle.dee[3]
      twiddle.dum[2] := twiddle.dee[0]
      twiddle.dum[3] := twiddle.dee[1]
      --twiddle.dum[3] := BYTE ((INT twiddle.dum[3]) + 127)
      INT16 dec.exp RETYPES [twiddle.dum FROM 2 FOR 2] :
      INT16 ieee.exp :
```

```
      VAL  zero IS  0 (INT16) :
      SEQ
        ieee.exp := dec.exp - 256 (INT16)
        IF
          (ieee.exp < zero) AND (dec.exp > zero)
            --{{{  fix very small number
            SEQ
              dec.exp := zero
            --}}}
          TRUE
            dec.exp := ieee.exp
:
--}}}
--{{{  PROC clear.screen
PROC clear.screen(CHAN OF SP fs, ts)
  SEQ
    goto.xy(fs, ts, 0,0)
    clear.eos(fs, ts)
:
--}}}
--{{{  PROC checkFloat
PROC checkFloat(VAL REAL32 in, REAL32 out)
  SEQ
    IF
      ISNAN(in)
        out := 0.0 (REAL32)
      (ABS(in)) > 1.0E+20 (REAL32)
        out := 1.0E+20 (REAL32)
      TRUE
        out := in
:
--}}}
--{{{  PROC message.buffer (CHAN in, out, stop)
PROC message.buffer (CHAN OF ANY in, out, stop)
  BYTE length :
  INT  any :
  BOOL continue :
  [max.message]INT buffer :
  SEQ
    continue := TRUE
    WHILE continue
      ALT
        stop ? any
          continue := FALSE
        in ? length::buffer
          out ! length::buffer
:
--}}}

--{{{  merge.sim.and fpa (CHAN)
PROC merge.sim.and.fpa (CHAN OF SP fs, ts, CHAN OF ANY to.seeker)
  --{{{  INT FUNCTION MIN (INT,INT)
  INT FUNCTION MIN (VAL INT a, b)
    INT return :
    VALOF
      IF
        a <= b
          return := a
        TRUE
          return := b
      RESULT return
  :
  --}}}
  SEQ
    --{{{  display some text
    so.write.string(fs, ts,
      "FPA and Sim values have all been loaded.*c*n")
```

```
      so.write.string(fs, ts,
        "Will now merge data sets and send to Seeker Emulator*c*n")
      so.write.string(fs, ts,
        "range, time, frame rate, and interceptor and target coordinates.*c*n")
      --}}}
      --{{{  compare sim frames to fpa frames
      INT frames.sent, frames.to.send, sim.count :
      SEQ
        --{{{  send sim.frames
        sim.count :- 0
        frames.sent := 0
        WHILE sim.time[sim.count] < fpa.time[0]
          SEQ
            --{{{  compute range values
            range IS sim.range[sim.count] :
            SEQ
              range := 0.0 (REAL32)
              SEQ i = 0 FOR 3
                VAL temp IS  (sim.position[i][sim.count] -
                              sim.position[i + 3][sim.count]) :
                range := range + (temp * temp)
              range := SQRT (range)
            --}}}
            sim.count := sim.count + 1
        WHILE frames.sent < sim.count
          SEQ
            frames.to.send := MIN(sim.count - frames.sent, max.buff.size)
            SEQ i = 0 FOR 6
              to.seeker ! BYTE (4 + frames.to.send) ;
                          c.sim.position; i; frames.sent ; frames.to.send ;
                          [sim.position[i] FROM frames.sent FOR frames.to.send]
            to.seeker ! BYTE (3 + frames.to.send) ;
                        c.frame.time ; frames.sent ; frames.to.send ;
                        [sim.time FROM frames.sent FOR frames.to.send]
            to.seeker ! BYTE (3 + frames.to.send) ;
                        c.frame.range ; frames.sent ; frames.to.send ;
                        [sim.range FROM frames.sent FOR frames.to.send]
            frames.sent := frames.sent + frames.to.send
        --}}}
        --{{{  get position values for fpa frames
        INT current.sim :
        SEQ
          current.sim := sim.count - 1
          SEQ i = 0 FOR num.frames
            SEQ
              WHILE ABS(fpa.time[i] - sim.time[current.sim+1]) <
                    ABS(fpa.time[i] - sim.time[current.sim])
                current.sim := current.sim + 1
              SEQ j = 0 FOR 6
                fpa.position[j][i] := sim.position[j][current.sim]
          SEQ i = 0 FOR 6
            to.seeker ! BYTE (4 + num.frames) ;
                        c.sim.position; i; sim.count ; num.frames ;
                        [fpa.position[i] FROM 0 FOR num.frames]
          to.seeker ! BYTE (3 + num.frames) ;
                      c.frame.time ; sim.count ; num.frames ;
                      [fpa.time FROM 0 FOR num.frames]
          to.seeker ! BYTE (3 + num.frames) ;
                      c.frame.rate ; sim.count ; num.frames ;
                      [frame.rate FROM 0 FOR num.frames]
          to.seeker ! BYTE (3 + num.frames) ;
                      c.frame.range ; sim.count ; num.frames ;
                      [fpa.range FROM 0 FOR num.frames]
          to.seeker ! BYTE (3) ;
                      c.sim.start.frames ; sim.count ; (sim.count + num.frames) -
1
        --}}}
```

```
    --}}}
  :
  --}}}
  --{{{  load.background (CHAN, CHAN)
  PROC load.background(CHAN OF SP fs, ts, CHAN OF ANY to.seeker)


    --{{{  local variables
    BYTE key, result :
    BOOL error :
    INT32 streamid :
    --}}}
    SEQ
      --{{{  welcome
      clear.screen (fs, ts)
      so.write.string (fs, ts, "Loading background data...*c*n")
      --}}}
      --{{{  get background frames
      REAL32 diam, fnum, pxspcx,
             pxspcy, filfax, filfay :
      --[max.frames]REAL32 framrt, range, time :
      BYTE cr :
      [128]BYTE file.name, base.name :
      INT fn.length, base.name.length :
      INT dummy :
      BYTE result :
      BOOL error :
      SEQ
        so.write.string(fs, ts, "*c*nNoise data...*c*n")
        --{{{  Get file name for FPA characteristics
        SEQ
          so.write.string   (fs, ts, "File name for FPA characteristics: ")
          so.read.echo.line (fs, ts, fn.length, file.name, result)
          so.write.nl       (fs, ts)
        --}}}
        --{{{  open file
        SEQ
          so.open (fs, ts, [file.name FROM 0 FOR fn.length], spt.binary,
                   spm.input, streamid, result)

          IF
            result <> spr.ok
              so.write.string (fs, ts, "Unable to open ")
            TRUE
              SKIP
          so.write.string.nl (fs, ts, [file.name FROM 0 FOR fn.length])
        --}}}
        --{{{  file header
        get.INT   (fs, ts, streamid, dummy)
        get.INT   (fs, ts, streamid, nnrows)
        get.INT   (fs, ts, streamid, nncols)
        get.REAL32   (fs, ts, streamid, diam)
        get.REAL32   (fs, ts, streamid, fnum)
        get.REAL32(fs, ts, streamid, pxspcx)
        get.REAL32(fs, ts, streamid, pxspcy)
        get.REAL32(fs, ts, streamid, filfax)
        get.REAL32(fs, ts, streamid, filfay)
        get.INT   (fs, ts, streamid, dummy)
        --}}}
        --{{{  qeff and dark current
        [max.cols][max.cols]REAL32 qeff.full, dkcurr.full :
        SEQ
          --{{{  quantum efficiency
          so.write.string(fs, ts, "Loading and sending quantum efficiency
data.*c*n")
```

```
          SEQ i = 0 FOR nnrows
            qeff IS qeff.full[i] :
            SEQ
              get.INT   (fs, ts, streamid, dummy)
              get.REAL32.vector(fs, ts, streamid,
                                [qeff FROM 0 FOR nncols])
              get.INT   (fs, ts, streamid, dummy)
              so.write.real32( fs, ts, qeff[0], 10, 3 )
              so.write.char( fs, ts, '*c' )
              -- to.seeker ! BYTE (2 + nncols );
              --             c.gain.row ; (nnrows - i) - 1 ; [qeff FROM 0 FOR
nncols]
              --{{{  replicate for smaller arrays
              INT count :
              SEQ
                count := nncols
                WHILE count < max.cols
                  SEQ
                    [qeff FROM count FOR nncols] := [qeff FROM 0 FOR nncols]
                    count := count + nncols
                SEQ j = 0 FOR (max.rows / nnrows)
                  to.seeker ! BYTE (2 + max.cols );
                              c.gain.row ; ((nnrows - i) - 1) + (j * nnrows);
                              [qeff FROM 0 FOR max.cols]
              --}}}
          --}}}

          --{{{  dark current
          so.write.string(fs, ts, "Loading and sending dark current data.*c*n")
          SEQ i = 0 FOR nnrows
            dkcurr IS dkcurr.full[i] :
            SEQ
              get.INT   (fs, ts, streamid, dummy)
              get.REAL32.vector(fs, ts, streamid,
                                [dkcurr FROM 0 FOR nncols])
              get.INT   (fs, ts, streamid, dummy)
              so.write.real32( fs, ts, dkcurr[0], 10, 3 )
              so.write.char( fs, ts, '*c' )
              --to.seeker ! BYTE (2 + nncols );
              --            c.offset.row ; (nnrows - i) - 1 ; [dkcurr FROM 0 FOR
nncols]
              --{{{  replicate for smaller arrays
              INT count :
              SEQ
                count := nncols
                WHILE count < max.cols
                  SEQ
                    [dkcurr FROM count FOR nncols] := [dkcurr FROM 0 FOR nncols]
                    count := count + nncols
                SEQ j = 0 FOR (max.rows / nnrows)
                  to.seeker ! BYTE (2 + max.cols );
                              c.offset.row ; ((nnrows - i) - 1) + (j * nnrows);
                              [dkcurr FROM 0 FOR max.cols]
              --}}}
            --}}}
        --}}}
        --{{{  close file
        so.close (fs, ts, streamid, result)
        --}}}
        so.write.string(fs, ts, "Loading noise data now.*c*n")
        --{{{  determine Noise data file name(s)
        BYTE result :
        BOOL error :
        SEQ
          so.write.string (fs, ts, "Base file name for Noise data: ")
          so.read.echo.line    (fs, ts, base.name.length, base.name, result)
          so.write.nl (fs, ts)
```

```
    IF
      num.frames = 0
        SEQ
          so.write.string (fs, ts, "Number of frames to read: ")
          so.read.echo.int(fs, ts, num.frames, error)
      TRUE
        SKIP

  --}}}
  SEQ i = 0 FOR num.frames
    --{{{  read and send data
    INT framid :
    SEQ
      --{{{  open file
      BYTE result :
      SEQ
        indexed.file.name (file.name, fn.length,
                           [base.name FROM 0 FOR base.name.length],
                           i+1, 3, ".out")
        so.open (fs, ts, [file.name FROM 0 FOR fn.length], spt.binary,
                 spm.input, streamid, result)

        IF
          result <> spr.ok
            SEQ
              so.write.string (fs, ts, "Unable to open ")
              so.write.string.nl (fs, ts, [file.name FROM 0 FOR fn.length])
          TRUE
            SKIP
      --}}}
      --{{{  frame header
      REAL32 temp :
      INT dummy :
      SEQ
        get.INT(fs, ts, streamid, dummy)
        get.INT(fs, ts, streamid, framid)
        get.INT(fs, ts, streamid, dummy)

        get.INT(fs, ts, streamid, dummy)
        get.REAL32(fs, ts, streamid, fpa.range[i])

        get.REAL32(fs, ts, streamid, fpa.time[i])

        get.REAL32(fs, ts, streamid, frame.rate[i])
        get.INT(fs, ts, streamid, dummy)

        get.INT(fs, ts, streamid, dummy)
        get.INT(fs, ts, streamid, nncols)

        get.INT(fs, ts, streamid, nnrows)
        get.INT(fs, ts, streamid, dummy)
      --}}}
      --{{{  show some data values
      so.write.int(fs, ts, framid, 10)
      so.write.int(fs, ts, nncols, 10)
      so.write.int(fs, ts, nnrows, 10)
      so.write.real32(fs, ts, fpa.range[i]  , 10, 3)
      so.write.real32(fs, ts, fpa.time[i]   , 10, 3)
      so.write.real32(fs, ts, frame.rate[i] , 10, 3)
      so.write.nl(fs, ts)
      --}}}
      SEQ j = 0 FOR nnrows
        [max.cols]REAL32 noise.data :
        INT dummy :
        SEQ
          --get.INT(fs, ts, streamid, dummy)
          --get.REAL32.vector(fs, ts, streamid,
```

```
                --                      [noise.data FROM 0 FOR nncols])
                --get.INT(fs, ts, streamid, dummy)
                SEQ temp = 0 FOR nncols
                  noise.data[temp] := 0.0 (REAL32)
                --{{{  replicate for smaller arrays
                INT count :
                SEQ
                  count := nncols
                  WHILE count < max.cols
                    SEQ
                      [noise.data FROM count FOR nncols] := [noise.data FROM 0 FOR
nncols]
                      count := count + nncols
                  SEQ k = 0 FOR (max.rows / nnrows)
                    to.seeker ! BYTE (3 + max.cols );
                                c.background.row ; i; ((nnrows - j) - 1) + (k *
nnrows);
                [noise.data FROM 0 FOR max.cols]
                --}}}
            --{{{  close file
            so.close (fs, ts, streamid, result)
            --}}}
          --}}}
      --}}}
      --{{{  send rate, time, and range
      to.seeker ! BYTE (3 + num.frames) ;
                  c.frame.time ; 0 ; num.frames ;
                  [fpa.time FROM 0 FOR num.frames]
      to.seeker ! BYTE (3 + num.frames) ;
                  c.frame.rate ; 0 ; num.frames ;
                  [frame.rate FROM 0 FOR num.frames]
      to.seeker ! BYTE (3 + num.frames) ;
                  c.frame.range ; 0 ; num.frames ;
                  [fpa.range FROM 0 FOR num.frames]
      to.seeker ! BYTE (3) ;
                  c.sim.start.frames ; 0 ;  num.frames - 1
      --}}}
      --{{{  so long
      so.write.nl (fs, ts)
      so.write.string(fs, ts, "Finished loading background data.*c*n ")
      --}}}
  :
  --}}}
  --{{{  load.target (CHAN, CHAN)
  PROC load.target (CHAN OF SP fs, ts, CHAN OF ANY to.seeker)

    --{{{  local variables
    BYTE key, result :
    BOOL error :
    INT nsize, start.frame :
    BYTE cr :
    INT32 streamid :
    [128]BYTE base.name, file.name :
    INT base.name.length, fn.length :
    --}}}
    SEQ
      --{{{  initialize
      nsize := nncols * 4
      --}}}
      --{{{  display title
      clear.screen(fs, ts)
      so.write.string(fs, ts, "Loading Target data now...*c*n")
      --}}}
      --{{{  clear old data
      --{{{  check number of frames
      IF
        num.frames = 0
```

```
    SEQ
      so.write.string (fs, ts, "Number of frames to read: ")
      so.read.echo.int(fs, ts, num.frames, error)
      so.write.nl (fs, ts)
  TRUE
    SKIP
--}}}
--{{{  zero old data
VAL num.full.rows IS nsize / sub.pixel.y :
VAL num.full.cols IS nsize / sub.pixel.x :
[max.t.cols]REAL32 target.data :
[sub.pixel.x][max.cols]REAL32 arranged.data :
SEQ
  --{{{  init
  SEQ i = 0 FOR max.t.cols
    target.data[i] := 0.0 (REAL32)
  --}}}
  --{{{  correct and format it
  INT count :
  SEQ
    count := 0
    SEQ j = 0 FOR num.full.cols
      SEQ k = 0 FOR sub.pixel.x
        SEQ
          arranged.data[k][j] := target.data[count]
          count := count + 1
  --}}}
  SEQ frame = 0 FOR 0
    SEQ
      so.write.int (fs, ts, frame, 5)
      so.write.char (fs,ts, '*c')
      SEQ i = 0 FOR nsize
        SEQ
          --{{{  send it
          VAL subpixel IS  (i \ sub.pixel.y) * sub.pixel.x :
          VAL current.row IS (i / sub.pixel.y) :
          SEQ j = 0 FOR sub.pixel.x
            SEQ
              to.seeker ! BYTE (4 + num.full.cols) ;
                          c.target.row ; frame ;
                          subpixel + j;
                          current.row ;
                          [arranged.data[j] FROM 0 FOR num.full.cols]

          --}}}
--}}}

--}}}
--{{{  determine file name(s)
BYTE result :
BOOL error :
SEQ
  so.write.string (fs, ts, "Base file name for Target data: ")
  so.read.echo.line    (fs, ts, base.name.length, base.name, result)
  so.write.nl (fs, ts)

--}}}
--{{{  get target frames
VAL num.full.rows IS nsize / sub.pixel.y :
VAL num.full.cols IS nsize / sub.pixel.x :
SEQ frame = 0 FOR num.frames
  SEQ
    --{{{  open file
    BYTE result :
    SEQ
      indexed.file.name (file.name, fn.length,
                         [base.name FROM 0 FOR base.name.length],
```

```
                                frame+1, 3, ".out")
          so.open (fs, ts, [file.name FROM 0 FOR fn.length], spt.binary,
                   spm.input, streamid, result)

          IF
            result <> spr.ok
              so.write.string (fs, ts, "Unable to open ")
            TRUE
              SKIP
          so.write.string (fs, ts, [file.name FROM 0 FOR fn.length])
          so.write.char (fs, ts, '*c')
        --}}}
        --{{{  read data  and send
        REAL32 temp :
        INT dummy :
        [2][max.t.cols]REAL32 target.data :
        [sub.pixel.x][max.cols]REAL32 arranged.data :
        SEQ
          --{{{  get first target row
          target IS target.data[0] :
          SEQ
            get.INT (fs, ts, streamid, dummy)
            get.REAL32.vector(fs, ts, streamid,
                              [target FROM 0 FOR nsize])
            get.INT (fs, ts, streamid, dummy)
          --}}}
          SEQ i = 0 FOR nsize
            PAR
              --{{{  get other target rows
              IF
                i = (nsize - 1)     -- done all rows
                  SKIP
                TRUE
                  target IS target.data[(i+1) /\ 1] :
                  SEQ
                    get.INT (fs, ts, streamid, dummy)
                    get.REAL32.vector(fs, ts, streamid,
                                      [target FROM 0 FOR nsize])
                    get.INT (fs, ts, streamid, dummy)
              --}}}
              SEQ
                --{{{  correct and format it
                target IS target.data[i /\ 1] :
                INT count :
                SEQ
                  count := 0
                  SEQ j = 0 FOR num.full.cols
                    SEQ k = 0 FOR sub.pixel.x
                      SEQ
                        arranged.data[k][j] := target[count]
                        count := count + 1
                --}}}
                --{{{  send it to seeker
                --VAL subpixel IS  ((sub.pixel.y - 1) - (i \ sub.pixel.y)) *
sub.pixel.x :
                --VAL current.row IS (num.full.rows - (i / sub.pixel.y)) - 1 :
                VAL subpixel IS  (i \ sub.pixel.y) * sub.pixel.x :
                VAL current.row IS (i / sub.pixel.y) :
                SEQ j = 0 FOR sub.pixel.x
                  SEQ
                    to.seeker ! BYTE (4 + num.full.cols) ;
                                c.target.row ; frame ;
                                subpixel + j;
                                current.row ;
                                [arranged.data[j] FROM 0 FOR num.full.cols]
                --}}}
      --}}}
```

```
        --{{{  close file
        so.close (fs, ts, streamid, result)
        --}}}
    --}}}
    --{{{  finish up
    INT dummy :
    SEQ
      so.write.nl(fs, ts)
      so.write.string(fs, ts, "Finished loading target data.*c*n ")
    --}}}
:
--}}}
--{{{  load.positions (CHAN, CHAN)
PROC load.positions (CHAN OF SP fs, ts, CHAN OF ANY from.vax, to.seeker)
  SEQ
    --{{{  load sim values
    BOOL continue :
    SEQ
      clear.screen(fs, ts)
      continue := TRUE
      num.sim.frames := 0
      WHILE continue
        SEQ
          --from.vax ? sim.time[num.sim.frames]
          SEQ i = 0 FOR 6
            --from.vax ? sim.position[i][num.sim.frames]
            SKIP
          --{{{  display values
          so.write.real32 (fs, ts, sim.time[num.sim.frames], 10, 3)
          so.write.char(fs, ts, '*c')
          --}}}
          IF
            sim.time[num.sim.frames] < 0.0 (REAL32)
              continue := FALSE
            TRUE
              num.sim.frames := num.sim.frames + 1
    --}}}
    --{{{  check if fpa values have been loaded
    IF
      fpa.values
        merge.sim.and.fpa (fs, ts, to.seeker)
      TRUE
        SKIP
    sim.values := TRUE
    --}}}
:
--}}}
--}}}

SEQ
  --{{{  initialize
  fpa.values := FALSE
  sim.values := FALSE
  num.frames := 0
  nncols := 128  -- default
  nnrows := 128  -- default
  --}}}
  --{{{  menu
  BYTE key, result :
  BOOL dont.exit :
  SEQ
    dont.exit := TRUE
    WHILE dont.exit
      SEQ
        --{{{  Loader Menu
        goto.xy( fs, ts, 0, 0 )
        clear.eos( fs, ts )
```

```
            so.write.string( fs, ts, "Load New Seeker Data Menu*c*n" )
            so.write.string( fs, ts, "----------------*c*n*n" )
            so.write.string( fs, ts, "*'Esc*' key to exit program.*c*n*n" )
            so.write.string( fs, ts, " (b)  background data*c*n" )
            so.write.string( fs, ts, " (t)  target data*c*n" )
            so.write.string( fs, ts, " (p)  position information*c*n" )

            so.getkey( fs, ts, key, result )
            --}}}
            CASE key
              --{{{  b - background data
              'B', 'b'
                load.background(fs, ts, to.seeker)
              --}}}
              --{{{  t - target
              'T', 't'
                load.target(fs, ts, to.seeker)
              --}}}
              --{{{  p - position info
              'P', 'p'
                load.positions(fs, ts, from.vax, to.seeker)
              --}}}
              --{{{  escape
              (BYTE esc)
                dont.exit := FALSE
              --}}}
              --{{{  else
              ELSE
                SKIP
              --}}}
    --}}}
:
```

4.1.21. RunSeekr.occ

```
--{{{  libraries
#INCLUDE "s_header.inc"
#INCLUDE "hostio.inc"
#USE "hostio.lib"
--}}}
PROC runSeeker (CHAN OF SP fs, ts, CHAN OF ANY fromSeeker, toSeeker)
  --{{{  utility procs
  --{{{  goto.xy
  PROC goto.xy (CHAN OF SP fs, ts, VAL INT x, y)
    VAL esc IS 27 (BYTE) :
    SEQ
      so.write.string (fs, ts, [esc, '['])
      so.write.int (fs, ts, y+1, 0)
      so.write.char (fs, ts, ';')
      so.write.int (fs, ts, x+1, 0)
      so.write.char (fs, ts, 'H')
  :
  --}}}
  --{{{  clear.eos
  PROC clear.eos (CHAN OF SP fs, ts)
    VAL esc IS 27 (BYTE) :
    SEQ
      so.write.string (fs, ts, [esc, '[', 'J'])
  :
  --}}}
  --{{{  so.get.extended.key
  PROC so.get.extended.key (CHAN OF SP fs, ts, INT extended.key)
    BYTE key, result :
    SEQ
      so.getkey( fs, ts, key, result)
      IF
        key = 0 (BYTE)
          SEQ
            so.getkey (fs, ts, key, result)
            extended.key := 256 + (INT key)
        TRUE
          extended.key := (INT key)
  :
  --}}}
  --{{{  get.real32
  PROC get.real32 ( CHAN OF SP fs, ts, REAL32 value )

    BOOL error :
    SEQ
      so.read.echo.real32( fs, ts, value, error )
      WHILE error
        SEQ
          so.write.string( fs, ts, "*c*nIllegal Real Number : " )
          so.read.echo.real32( fs, ts, value, error )
  :
  --}}}
  --{{{  get.int
  PROC get.int ( CHAN OF SP fs, ts, INT value )

    BOOL error :
    SEQ
      so.read.echo.int( fs, ts, value, error )
      WHILE error
        SEQ
          so.write.string( fs, ts, "*c*nIllegal Integer : " )
          so.read.echo.int( fs, ts, value, error )
  :
  --}}}
  --}}}
```

```
--{{{  constants
VAL esc IS 27 :
--}}}
--{{{  move.table
VAL move.table  IS   [ [ 328,   0,  1 ],      -- up
                       [ 336,   0, -1 ],      -- down
                       [ 331,   1,  0 ],      -- left
                       [ 333,  -1,  0 ],      -- right
                       [ 329,  -1,  1 ],      -- up and right
                       [ 337,  -1, -1 ],      -- down and right
                       [ 335,   1, -1 ],      -- down and left
                       [ 327,   1,  1 ],      -- up and left
                       [  56,   0,  4 ],      -- up
                       [  50,   0, -4 ],      -- down
                       [  52,   4,  0 ],      -- left
                       [  54,  -4,  0 ],      -- right
                       [  57,  -4,  4 ],      -- up and right
                       [  51,  -4, -4 ],      -- down and right
                       [  49,   4, -4 ],      -- down and left
                       [  55,   4,  4 ] ] :   -- up and left
--}}}
--{{{  variables
BYTE key, result :
BOOL running :
--}}}
SEQ
  --{{{  initialize
  so.write.string( fs, ts, "Initialize Start Frame (y/n) ")
  so.getkey (fs, ts, key, result)
  CASE key
    'Y', 'y'
      toSeeker ! 3(BYTE); c.sim.start.frames; 0; 0
    ELSE
      SKIP

  toSeeker ! 1(BYTE); c.test.controller
  toSeeker ! 2(BYTE); c.global.scale; 0.5E-3(REAL32)
  toSeeker ! 6(BYTE); c.set.calibration; 2;
                      2000000.0(REAL32); 80000000.0(REAL32); 750; 30000

  running := TRUE
  --}}}
  WHILE running
    SEQ
      --{{{  Run Seeker Menu
      goto.xy( fs, ts, 0, 0 )
      clear.eos( fs, ts )
      so.write.string( fs, ts, "Run Seeker Menu*c*n" )
      so.write.string( fs, ts, "-----------------*c*n*n" )
      so.write.string( fs, ts, "*'Esc*' key to return to previous menu.*c*n*n" )
      so.write.string( fs, ts, " ( )  single frame step*c*n" )
      so.write.string( fs, ts, " (a)  set to first fpa frame*c*n" )
      so.write.string( fs, ts, " (c)  continous mode*c*n" )
      so.write.string( fs, ts, " (f)  set frame number*c*n" )
      so.write.string( fs, ts, " (g)  initialize guidance*c*n" )
      so.write.string( fs, ts, " (r)  restart from calibration*c*n" )
      so.write.string( fs, ts, " (s)  set A/D gain*c*n" )
      so.write.string( fs, ts, " (t)  set test mode*c*n" )
      so.write.string( fs, ts, " (x)  set first and last frame*c*n" )
      so.write.string( fs, ts, " (z)  set calibration*c*n" )
      so.write.nl( fs, ts )

      so.getkey( fs, ts, key, result )
      --}}}
      CASE key
        --{{{  single frame
        ' '
```

```
            toSeeker ! 1(BYTE); c.run.single
          --}}}
          --{{{  continuous
          'C', 'c'
            INT key :
            SEQ
              --{{{  display continuous menu
              goto.xy (fs, ts, 0, 0)
              clear.eos (fs, ts)
              so.write.string( fs, ts, "Continuous Mode*c*n" )
              so.write.string( fs, ts, "---------------*c*n*n" )
              so.write.string( fs, ts, "*'Esc*' key to return to previous
menu.*c*n" )
              so.write.string( fs, ts, " Press cursor keys to shift image*c*n*n" )
              so.write.string( fs, ts, " Home    |    PgUp*c*n*n" )
              so.write.string( fs, ts, " <---           --->*c*n*n" )
              so.write.string( fs, ts, " End     |    PgDn*c*n*n" )
              so.write.string( fs, ts, " Use *'Shift*' key for faster movement." )
              --}}}
              toSeeker ! 1(BYTE);c.run.continuous
              so.get.extended.key (fs, ts, key)
              WHILE (key <> esc)
                SEQ
                  IF
                    IF i = 0 FOR SIZE move.table
                      key = move.table[i][0]
                        toSeeker ! cc.shift.image; move.table[i][1];
move.table[i][2]
                    TRUE
                      SKIP
                  so.get.extended.key (fs, ts, key)
              toSeeker ! cc.exit
          --}}}
          --{{{  restart
          'R', 'r'
            toSeeker ! 1(BYTE); c.restart
          --}}}
          --{{{  start from first fpa image
          'A', 'a'
            toSeeker ! 4(BYTE); c.start.frame; 1; 0; 1
          --}}}
          --{{{  scale
          'S', 's'
            REAL32 scale :
            SEQ
              so.write.string( fs, ts, "*c*nEnter new scale: " )
              get.real32( fs, ts, scale )
              toSeeker! 2(BYTE); c.global.scale; scale
          --}}}
          --{{{  test mode
          'T', 't'
            INT key :
            SEQ
              toSeeker ! 1(BYTE); c.test.background
              toSeeker ! 1(BYTE); c.test.controller
          --}}}
          --{{{  frame
          'F', 'f'
            INT relative, frame :
            SEQ
              so.write.string (fs, ts, "*c*nChange frame (y/n)? ")
              so.getkey (fs, ts, key, result)
              CASE key
                'Y', 'y'
                  --{{{  get frame
                  SEQ
                    so.write.string (fs, ts, "*c*nStart relative to first FPA
```

```
frame (y/n)? ")
                    so.getkey (fs, ts, key, result)
                    CASE key
                      'Y', 'y'
                        relative := 1
                      ELSE
                        relative := 0
                    so.write.string( fs, ts, "*c*nStart Frame: " )
                    get.int( fs, ts, frame )
                  --}}}
                ELSE
                  relative := -1
              so.write.string (fs, ts, "*c*nDisplay fixed frame (y/n)? ")
              so.getkey (fs, ts, key, result)
              CASE key
                'Y', 'y'
                  toSeeker ! 4(BYTE); c.start.frame; relative; frame; 0
                ELSE
                  toSeeker ! 4(BYTE); c.start.frame; relative; frame; 1
          --}}}
          --{{{  set calibration
          'Z', 'z'
            REAL32 c0, c1 :
            INT sp0, sp1 :
            SEQ
              so.write.string( fs, ts, "*c*nLevel for First Calibration on Seeker:
" )
              get.real32( fs, ts, c0 )
              so.write.string( fs, ts, "*c*nLevel for Second Calibration on
Seeker: " )
              get.real32( fs, ts, c1 )
              so.write.string( fs, ts, "*c*nLevel for First Calibration on SP: " )
              get.int( fs, ts, sp0 )
              so.write.string( fs, ts, "*c*nLevel for Second Calibration on SP: "
)
              get.int( fs, ts, sp1 )
              toSeeker ! 6(BYTE); c.set.calibration; 2; c0; c1; sp0; sp1

          --}}}
          --{{{  set first frame
          'X', 'x'
            INT first, last :
            SEQ
              so.write.string( fs, ts, "*c*nEnter value for first frame: " )
              get.int( fs, ts, first )
              so.write.string( fs, ts, "*c*nEnter value for last frame: " )
              get.int( fs, ts, last )
              toSeeker ! 3(BYTE); c.sim.start.frames; first; last
          --}}}
          --{{{  guidance initialize
          'G', 'g'
            BOOL not.valid.key, abort :
            SEQ
              --{{{  display guidance menu
              goto.xy (fs, ts, 0, 0)
              clear.eos (fs, ts)
              so.write.string( fs, ts, "Guidance Selection*c*n" )
              so.write.string( fs, ts, "------------------*c*n*n" )
              so.write.string( fs, ts, "*'Esc*' key to return to previous
menu.*c*n*n" )
              so.write.string( fs, ts, " (x)  crossbar test*c*n" )
              so.write.string( fs, ts, " (i)  internal test*c*n" )
              so.write.string( fs, ts, " (n)  no guidance*c*n" )
              --}}}
              not.valid.key := TRUE
              WHILE not.valid.key
                SEQ
```

```
                not.valid.key := FALSE
                abort := FALSE
                so.getkey (fs, ts, key, result)
                CASE key
                  --{{{  x
                  'X', 'x'
                    toSeeker ! 2(BYTE); c.guidance.set.mode; gm.external
                  --}}}
                  --{{{  i
                  'I', 'i'
                    toSeeker ! 2(BYTE); c.guidance.set.mode; gm.internal
                  --}}}
                  --{{{  n
                  'N', 'n'
                    toSeeker ! 2(BYTE); c.guidance.set.mode; gm.none
                  --}}}
                  --{{{  escape
                  (BYTE esc)
                    abort := TRUE
                  --}}}
                  --{{{  else
                  ELSE
                    not.valid.key := TRUE
                  --}}}
              IF
                abort
                  SKIP
                TRUE
                  toSeeker ! 1(BYTE); c.guidance.initialize
            --}}}
            --{{{  escape
            (BYTE esc)
              running := FALSE
            --}}}
            --{{{  other
            ELSE
              SKIP
            --}}}
:
```

4.1.22. SecondBuffer.occ

```
PROC SecondBuffer ( CHAN OF ANY in, fromNext, toPrev, to.out,
                    VAL INT position, shift )

  --{{{  constants
  --}}}
  --{{{  variables
  [2][64] INT input.buffer :
  INT count :
  --}}}
  --{{{  channels
  CHAN OF ANY synch, internal, internal2 :
  --}}}
  --{{{  Receiver
  PROC Receiver ( CHAN OF ANY in, out, [2][64] INT buffer )

    INT i :
    SEQ
      i := 0
      WHILE TRUE
        SEQ
          in ? buffer[i]
          out ! i
          i := 1 - i
  :
  --}}}
  --{{{  Extractor
  PROC Extractor ( CHAN OF ANY internal, in, out, out2,
                   VAL INT count, position )

    --{{{  variables
    [2][64][2] BYTE buffer :
    INT output :
    --}}}
    SEQ
      internal ? buffer[0]
      output := 0
      WHILE TRUE
        SEQ
          SEQ i = 0 FOR count
            SEQ
              PAR
                out ! buffer[output]
                IF
                  (position = 0) OR (position = 8)
                    out2 ! buffer[output]
                  TRUE
                    SKIP
                in ? buffer[ 1-output ]
              output := 1 - output
          PAR
            IF
              (position = 0) OR (position = 8)
                out2 ! buffer[output]
              TRUE
                SKIP
            out ! buffer[output]
            internal ? buffer[1-output]
          output := 1 - output
  :
  --}}}
  --{{{  Formatter
  PROC Formatter ( CHAN OF ANY synch, out,
                   [2][64] INT input.buffer )
```

```
    --{{{  variables
    [2][64][4] BYTE b.in RETYPES input.buffer :
    [64][2] BYTE buffer :
    [64*2] BYTE buffer1 RETYPES buffer :
    INT in.ptr :
    --}}}
    SEQ
      WHILE TRUE
        SEQ
          --{{{  form message in buffer
          SEQ
            synch ? in.ptr

            source IS input.buffer[in.ptr] :
            INT p :
            SEQ
              p := 0
              SEQ i = 0 FOR 64
                INT store :
                SEQ
                  store := source[i] >> shift
                  --{{{  check for zeroing store
                  IF
                    store = 0
                      IF
                        source[i] <> 0
                          store := 1
                        TRUE
                          store := 0
                    TRUE
                      SKIP
                  --}}}
                  buffer1[p] := BYTE store
                  buffer1[p+1] := BYTE store
                  p := p + 2
          --}}}
          out ! buffer
  :
  --}}}
  --{{{  GTSPI.Formatter
  PROC GTSPI.Formatter (CHAN OF ANY in, out)
    --{{{  variables
    [2][64][2]BYTE buffer :
    [2][8][64][2]BYTE master.format.buffer :
    INT output, input :
    --}}}
    CHAN OF ANY sync :
    SEQ
      input := 0
      output := 0
      PAR
        --{{{  input and format
        WHILE TRUE
          SEQ
            in ? buffer[0]
            SEQ i = 0 FOR 8
              SEQ
                PAR
                  --{{{  input
                  IF
                    i = 7
                      SKIP
                    TRUE
                      in ? buffer[(i+1) /\ 1]
                  --}}}
                  --{{{  process
                  [8][64]INT16 format.buffer RETYPES master.format.buffer[input] :
```

```
                [8][8]INT16 work.buffer RETYPES buffer[i /\ 1] :
                --format.buffer IS master.format.buffer[input] :
                --work.buffer   IS buffer[i /\ 1] :
                --[64][16]BYTE format.buffer.f RETYPES format.buffer :
                --SEQ
                --  MOVE2D ( work.buffer, 0, 0,
                --           format.buffer.f, i * 2, 0, 2, 64)
                SEQ l = 0 FOR 8
                  VAL base IS (l TIMES 8) + i:
                  SEQ
                    format.buffer[0][base] := work.buffer[0][l]
                    format.buffer[1][base] := work.buffer[1][l]
                    format.buffer[2][base] := work.buffer[2][l]
                    format.buffer[3][base] := work.buffer[3][l]
                    format.buffer[4][base] := work.buffer[4][l]
                    format.buffer[5][base] := work.buffer[5][l]
                    format.buffer[6][base] := work.buffer[6][l]
                    format.buffer[7][base] := work.buffer[7][l]
                --}}}
            input := 1 - input
            sync ! 1
        --}}}
        --{{{  output
        WHILE TRUE
          INT ok :
          SEQ
            sync ? ok
            out ! master.format.buffer[output]
            output := 1 - output
        --}}}
  :
  --}}}

  SEQ
    IF
      position < 8
        count := 7 - position
      TRUE
        count := 15 - position
    PRI PAR
      PAR
        Receiver( in, synch, input.buffer )
        Extractor( internal, fromNext, toPrev, internal2, count, position )
        --{{{  GTSPI.Formatter
        IF
          (position = 0) OR (position = 8)
            GTSPI.Formatter (internal2, to.out)
          TRUE
            SKIP
        --}}}
      Formatter( synch, internal, input.buffer )
:
```

4.1.23. SP.occ

```
PROC SP ( CHAN OF ANY in, out, fromPrev, toPrev, fromNext, toNext,
          VAL INT position )

  #INCLUDE "s_header.inc"
  --{{{  constants
  VAL  packet.length    IS   8 :
  VAL  num.packets      IS   (128 * 8) / packet.length :

  VAL  fraction.bits    IS    8 :
  VAL  tolerance        IS    4 :
  --}}}
  --{{{  ProcessFrame
  PROC ProcessFrame ( CHAN OF ANY in, out,
                      VAL INT lower.threshold, upper.threshold,
                      [128][8] INT Gain, Offset,
                      INT  max.data, max.row, max.col )

    --{{{  constants
    VAL  l.thr   IS   lower.threshold << fraction.bits :
    VAL  u.thr   IS   upper.threshold << fraction.bits :
    --}}}
    --{{{  ProcessRow
    PROC ProcessRow ( [packet.length] INT data, gain, offset, VAL INT row )

      SEQ i = 0 FOR packet.length
        INT value :
        SEQ
          value := (data[i] TIMES gain[i]) + offset[i]
          IF
            value < l.thr
              data[i] := 0
            value > u.thr
              data[i] := upper.threshold
            TRUE
              data[i] := value >> fraction.bits
          --{{{  find hot spot
          IF
            data[i] > max.data
              SEQ
                max.data := data[i]
                max.row  := row
                max.col  := i
            TRUE
              SKIP
          --}}}
    :
    --}}}
    --{{{  retype array to packet.length
    [num.packets][packet.length] INT  p.gain        RETYPES Gain       :
    [num.packets][packet.length] INT  p.offset      RETYPES Offset     :
    --}}}
    --{{{  variables
    INT in.ptr, out.ptr, process.ptr, temp :
    [3][packet.length] INT buffer :
    PLACE buffer IN WORKSPACE :
    --}}}
    SEQ
      --{{{  initialize
      in.ptr := 2
      process.ptr := 1
      out.ptr := 0

      max.data := -1
      max.row := 0
```

```
    max.col := 0
    --}}}
    --{{{  get first row
    in ? buffer[0]
    --}}}
    --{{{  get second row and process first row
    PRI PAR
      in ? buffer[1]
      ProcessRow( buffer[0], p.gain[1], p.offset[1], 0 )
    --}}}
    --{{{  do middle rows
    SEQ row = 1 FOR (num.packets-2)
      SEQ
        PRI PAR
          PAR
            in ? buffer[in.ptr]
            out ! buffer[out.ptr]
          ProcessRow( buffer[process.ptr], p.gain[row], p.offset[row], row )
        temp := out.ptr
        out.ptr := process.ptr
        process.ptr := in.ptr
        in.ptr := temp
    --}}}
    --{{{  process last row
    VAL i IS num.packets - 1 :
    PRI PAR
      out ! buffer[out.ptr]
      ProcessRow( buffer[process.ptr],  p.gain[i], p.offset[i], i )
    --}}}
    --{{{  output last row
    out ! buffer[ process.ptr ]
    --}}}
    --{{{  determine actual max.col position
    max.col := (max.col << 4) + position
    --}}}
:
--}}}
--{{{  CalibrateFrame
PROC CalibrateFrame ( CHAN OF ANY in, out,
                      VAL INT c.frame, c.level,
                      [128][8] INT Gain, Offset )

  --{{{  global variables
  INT D0, D1, d0, delta.D, half.range :
  --}}}
  --{{{  ProcessRow
  PROC ProcessRow ( [packet.length] INT data, gain, offset )

    IF
      c.frame = 0
        gain := data
      TRUE
        SEQ i = 0 FOR packet.length
          INT previous.pixel, delta.p :
          SEQ
            previous.pixel := gain[i]
            delta.p := data[i] - previous.pixel
            IF
              delta.p < tolerance
                --{{{  dead pixel
                SEQ
                  gain[i] := 0
                  offset[i] := (previous.pixel - tolerance) << fraction.bits
                --}}}
              TRUE
                --{{{  normal pixel
                SEQ
```

```
                    gain[i] := delta.D / delta.p
                    offset[i] := (d0 - (gain[i] TIMES previous.pixel)) +
half.range
                  --}}}
    :
    --}}}
    --{{{  retype array to packet.length
    [num.packets][packet.length] INT  p.gain        RETYPES Gain       :
    [num.packets][packet.length] INT  p.offset      RETYPES Offset     :
    --}}}
    --{{{  variables
    INT in.ptr, out.ptr, process.ptr, temp :
    [3][packet.length] INT buffer :
    PLACE buffer IN WORKSPACE :
    --}}}
    SEQ
      --{{{  set up calibration
      IF
        c.frame = 0
          D0 := c.level
        TRUE
          SEQ
            D1 := c.level
            delta.D := (D1 - D0) << fraction.bits
            d0 := D0 << fraction.bits
            half.range := 1 << (fraction.bits-1)
      --}}}
      in.ptr := 2
      process.ptr := 1
      out.ptr := 0
      --{{{  get first row
      in ? buffer[0]
      --}}}
      --{{{  get second row and process first row
      PRI PAR
        in ? buffer[1]
        ProcessRow( buffer[0], p.gain[1], p.offset[1] )
      --}}}
      --{{{  do middle rows
      SEQ row = 1 FOR (num.packets-2)
        SEQ
          PRI PAR
            PAR
              in ? buffer[in.ptr]
              out ! buffer[out.ptr]
            ProcessRow( buffer[process.ptr], p.gain[row], p.offset[row] )
          temp := out.ptr
          out.ptr := process.ptr
          process.ptr := in.ptr
          in.ptr := temp
      --}}}
      --{{{  process last row
      VAL i IS num.packets - 1 :
      PRI PAR
        out ! buffer[out.ptr]
        ProcessRow( buffer[process.ptr],  p.gain[i], p.offset[i] )
      --}}}
      --{{{  output last row
      out ! buffer[ process.ptr ]
      --}}}
  :
  --}}}
  --{{{  variables
  --{{{  command variables
  BYTE length :
  [max.message] INT message :
  command IS message[0] :
```

```
  params IS [message FROM 1 FOR (max.message-1)] :
  --}}}

  [128][8] INT Gain, Offset :
  INT max.data, max.row, max.col :
  --}}}
  SEQ
    --{{{  initialize
    --}}}
    WHILE TRUE
      SEQ
        --{{{  get command and pass on
        fromPrev ? length::message
        IF
          position < 15
            toNext ! length::message
          TRUE
            SKIP
        --}}}
        --{{{  process command
        CASE command
          --{{{  c.sp.frame
          c.sp.frame
            IF
              params[0] < 0
                SEQ
                  ProcessFrame( in, out, params[2], params[3], Gain, Offset,
                                max.data, max.row, max.col )
                  --{{{  return hot spot
                  --IF
                  --  position < 15
                  --    INT next.data, next.row, next.col :
                  --    SEQ
                  --      fromNext ? next.data; next.row; next.col
                  --      IF
                  --        next.data > max.data
                  --          toPrev ! next.data; next.row; next.col
                  --        TRUE
                  --          toPrev ! max.data; max.row; max.col
                  --  TRUE
                  --    toPrev ! max.data; max.row; max.col

                  --}}}
              TRUE
                CalibrateFrame( in, out, params[0], params[1], Gain, Offset )
          --}}}
        --}}}
:
```

4.1.24. SPControl.occ

```
PROC SPController ( CHAN OF ANY fromController, toController,
                                fromGuidance, toGuidance,
                                fromGraphics, toGraphics, fromSP, toSP )

  --{{{  control SP and give guidance commands
  #INCLUDE "s_header.inc"
  --{{{  variables
  BYTE length :
  [max.message] INT message :
  command IS message[0] :
  params IS [message FROM 1 FOR (max.message-1)] :
  INT shift.x, shift.y :
  INT shift.command :
  --}}}
  SEQ
    WHILE TRUE
      ALT
        --{{{  transfer shift command from guidance to controller
        fromGuidance ? shift.command; shift.x; shift.y
          SEQ
            toController ! shift.command; shift.x; shift.y
        --}}}
        fromController ? length::message
          IF
            --{{{  Guidance commands
            (command >= 1280) AND (command < 1536)
              toGuidance ! length::message
            --}}}
            --{{{  Track Display commands
            (command >= 1536) AND (command < 1792)
              toGraphics ! length::message
            --}}}
            --{{{  c.sp.frame
            command = c.sp.frame
              PAR
                toSP ! length::message
                IF
                  params[0] < 0
                    --{{{  regular frame
                    [4]REAL32 r.param RETYPES [params FROM 4 FOR 4] :
                    [4]REAL32 d.param :
                    PAR
                      toGuidance ! 3(BYTE); c.guidance.run; [params FROM 4 FOR 2]
                      toGraphics ! 6(BYTE); c.display.info; 1; [params FROM 4 FOR
4]
                      --SEQ
                      --  d.param[0] := r.param[0] * 1.0 (REAL32)  --scaling
factors
                      --  d.param[1] := r.param[1] * 1.0 (REAL32)  -- (removed)
                      --  d.param[2] := r.param[2]
                      --  d.param[3] := r.param[3] * 1.0 (REAL32)
                      --  toGraphics ! 6(BYTE); c.display.info; 1; [d.param FROM 0
FOR 4]
                    --}}}
                  TRUE
                    --{{{  calibration frame
                    SEQ
                      toGraphics ! 6(BYTE); c.display.info; 1;
                                            [params FROM 4 FOR 4]
                    --}}}
            --}}}
            --{{{  c.read.graphics
            command = c.read.graphics
              INT bufLength :
```

```
                INT number.of.transfers :
                [maxGraphicBuffer]BYTE graphicsBuffer :
                SEQ
                  toGraphics   ! length::message
                  fromGraphics ? number.of.transfers
                  toController ! number.of.transfers
                  SEQ i = 0 FOR number.of.transfers
                    SEQ
                      fromGraphics ? bufLength::graphicsBuffer
                      toController ! bufLength::graphicsBuffer
              --}}}
  --}}}
:
```

4.1.25. Target.occ

```
PROC Target ( CHAN OF ANY fromDown, toDown, fromUp, toUp,
              VAL INT column.position, row.position )

  #INCLUDE "s_header.inc"
  --{{{  constants
  VAL first.row  IS  row.position TIMES 16 :
  VAL next.first.row  IS  first.row + 16 :
  --}}}
  --{{{  SendFrame
  PROC SendFrame ( CHAN OF ANY in, out, [16][8] REAL32 target,
                   VAL INT shift.y, shift.x )

    --{{{  variables
    INT start.col, crossbar.offset :
    INT total.in, diff :
    INT output :

    [16][8] INT buffer :
    [2][8] INT b :
    --}}}
    SEQ
      --{{{  calculate values
      crossbar.offset := shift.x /\ 15
      start.col := shift.x >> 4
      IF
        column.position < crossbar.offset
          start.col := start.col + 1
        TRUE
          SKIP

      total.in := (7 - row.position) << 4
      --}}}
      --{{{  shift target data
      [16][8*4] BYTE b.buffer RETYPES buffer :
      [16][8*4] BYTE b.target RETYPES target :

      VAL start IS start.col << 2 :
      VAL length IS (8 - start.col) << 2 :
      SEQ
        IF
          start <> 32
            MOVE2D( b.target, start, 0, b.buffer, 0, 0, length, 16 )
          TRUE
            SKIP
        IF
          start.col <> 0
            MOVE2D( b.target, 0, 0, b.buffer, length, 0, start, 16 )
          TRUE
            SKIP
      --}}}
      --{{{  send target data
      diff := shift.y - (row.position << 4)
      IF
        row.position = 7
          --{{{  no one is above you
          SEQ
            IF
              diff < 1
                diff := 0
              TRUE
                SKIP
            SEQ i = diff FOR (16-diff)
              out ! buffer[i]
            SEQ i = 0 FOR diff
```

```
            out ! buffer[i]
        --}}}
      diff < 0
        --{{{  start row is below
        SEQ
          PAR
            in ? b[0]
            SEQ i = 0 FOR 16
              out ! buffer[i]
          output := 0
          SEQ i = 0 FOR (total.in - 1)
            SEQ
              PAR
                in ? b[1-output]
                out ! b[output]
              output := 1-output
          out ! b[output]
        --}}}
      (diff - 16) <= 0
        --{{{  start row is in the middle
        SEQ
          PAR
            in ? b[0]
            SEQ i = diff FOR 16-diff
              out ! buffer[i]
          output := 0
          SEQ i = 0 FOR (total.in - 1)
            SEQ
              PAR
                in ? b[1-output]
                out ! b[output]
              output := 1-output
          out ! b[output]
          SEQ i = 0 FOR diff
            out ! buffer[i]
        --}}}
      TRUE
        --{{{  start row is in middle of processor further down
        SEQ
          in ? b[0]
          output := 0
          SEQ i = 0 FOR (127 - shift.y)
            SEQ
              PAR
                in ? b[1-output]
                out ! b[output]
              output := 1-output
          out ! b[output]
          PAR
            in ? b[output]
            SEQ i = 0 FOR 16
              out ! buffer[i]
          SEQ i = 0 FOR ((total.in + shift.y) - 129)
            SEQ
              PAR
                in ? b[1-output]
                out ! b[output]
              output := 1-output
          out ! b[output]
        --}}}
    --}}}
:
--}}}
--{{{  GetTargetRow
PROC GetTargetRow ( [16][8] REAL32 Target, VAL INT row, [128] INT data )

  [] REAL32 r.data RETYPES data :
```

```
      IF
        (row >= first.row) AND (row < next.first.row)
          SEQ i = 0 FOR 8
            Target[ row-first.row ][ i ] := r.data[ (i*16) + column.position ]
        TRUE
          SKIP
:
--}}}
--{{{  variables
BYTE length :
[max.message] INT message :
command IS message[0] :
params IS [message FROM 1 FOR (max.message-1)] :

[max.frames][16][16][8] REAL32 Frame :
--}}}
SEQ
  --{{{  initialize last target frame
  SEQ r = 0 FOR 64
    SEQ c = 0 FOR 8
      SEQ o = 0 FOR 4
        INT column, row :
        REAL32 value :
        SEQ
          --{{{  determine col value
          column := (((c << 6) + o) + (column.position << 2)) + 1
          IF
            column < 256
              SKIP
            TRUE
              column := 513 - column
          --}}}
          --{{{  determine row value
          row := ((first.row << 2) + r) + 1
          IF
            row < 256
              SKIP
            TRUE
              row := 513 - row
          --}}}
          value  :=  REAL32 ROUND( (row * column)  )
          Frame[max.frames-1][((r/\3)<<2)+o][r>>2][c] := value
  --}}}
  WHILE TRUE
    SEQ
      --{{{  get command and send up
      fromDown ? length::message
      IF
        row.position < 7
          toUp ! length::message
        TRUE
          SKIP
      --}}}
      CASE command
        --{{{  c.set.target
        c.set.target
          SendFrame( fromUp, toDown, Frame[ params[0] ][ params[1] ],
                     params[2], params[3] )
        --}}}
        --{{{  c.target.row
        c.target.row
          GetTargetRow( Frame[ params[0] ][ params[1] ], params[2],
                        [params FROM 3 FOR 128] )
        --}}}
:
```

4.1.26. TargetLead.occ

```
PROC TargetLead ( CHAN OF ANY fromUp, toUp, toDown,
                              fromPrev, toPrev, fromNext, toNext,
                  VAL INT column.position )

  #INCLUDE "s_header.inc"
  --{{{  constants
  VAL row.position     IS  0 :
  VAL first.row        IS  0 :
  VAL next.first.row   IS 16 :
  --}}}
  --{{{  SendFrame
  PROC SendFrame ( CHAN OF ANY in, out, [16][8] REAL32 target,
                   VAL INT shift.y, shift.x )

    --{{{  variables
    INT start.col, crossbar.offset :
    INT total.in, diff :
    INT output :

    [16][8] INT buffer :
    [2][8] INT b :
    --}}}
    SEQ
      --{{{  calculate values
      crossbar.offset := shift.x /\ 15
      start.col := shift.x >> 4
      IF
        column.position < crossbar.offset
          start.col := start.col + 1
        TRUE
          SKIP

      total.in := (7 - row.position) << 4
      --}}}
      --{{{  shift target data
      [16][8*4] BYTE b.buffer RETYPES buffer :
      [16][8*4] BYTE b.target RETYPES target :

      VAL start IS start.col << 2 :
      VAL length IS (8 - start.col) << 2 :
      SEQ
        IF
          start <> 32
            MOVE2D( b.target, start, 0, b.buffer, 0, 0, length, 16 )
          TRUE
            SKIP
        IF
          start.col <> 0
            MOVE2D( b.target, 0, 0, b.buffer, length, 0, start, 16 )
          TRUE
            SKIP
      --}}}
      --{{{  send target data
      diff := shift.y - (row.position << 4)
      IF
        row.position = 7
          --{{{  no one is above you
          SEQ
            IF
              diff < 1
                diff := 0
              TRUE
                SKIP
            SEQ i = diff FOR (16-diff)
```

```
            out ! buffer[i]
          SEQ i = 0 FOR diff
            out ! buffer[i]
        --}}}
      diff < 0
        --{{{  start row is below
        SEQ
          PAR
            in ? b[0]
            SEQ i = 0 FOR 16
              out ! buffer[i]
          output := 0
          SEQ i = 0 FOR (total.in - 1)
            SEQ
              PAR
                in ? b[1-output]
                out ! b[output]
              output := 1-output
          out ! b[output]
        --}}}
      (diff - 16) <= 0
        --{{{  start row is in the middle
        SEQ
          PAR
            in ? b[0]
            SEQ i = diff FOR 16-diff
              out ! buffer[i]
          output := 0
          SEQ i = 0 FOR (total.in - 1)
            SEQ
              PAR
                in ? b[1-output]
                out ! b[output]
              output := 1-output
          out ! b[output]
          SEQ i = 0 FOR diff
            out ! buffer[i]
        --}}}
      TRUE
        --{{{  start row is in middle of processor further down
        SEQ
          in ? b[0]
          output := 0
          SEQ i = 0 FOR (127 - shift.y)
            SEQ
              PAR
                in ? b[1-output]
                out ! b[output]
              output := 1-output
          out ! b[output]
          PAR
            in ? b[output]
            SEQ i = 0 FOR 16
              out ! buffer[i]
          SEQ i = 0 FOR ((total.in + shift.y) - 129)
            SEQ
              PAR
                in ? b[1-output]
                out ! b[output]
              output := 1-output
          out ! b[output]
        --}}}
    --}}}
:
--}}}
--{{{  GetTargetRow
PROC GetTargetRow ( [16][8] REAL32 Target, VAL INT row, [128] INT data )
```

```
  [] REAL32 r.data RETYPES data :
  IF
    (row >= first.row) AND (row < next.first.row)
      SEQ i = 0 FOR 8
        Target[ row-first.row ][ i ] := r.data[ (i*16) + column.position ]
    TRUE
      SKIP
:
--}}}
--{{{  variables
BYTE length :
[max.message] INT message :
command IS message[0] :
params IS [message FROM 1 FOR (max.message-1)] :

[max.frames][16][16][8] REAL32 Frame :
--}}}
SEQ
  --{{{  initialize last target frame
  SEQ r = 0 FOR 64
    SEQ c = 0 FOR 8
      SEQ o = 0 FOR 4
        INT column, row :
        REAL32 value :
        SEQ
          --{{{  determine col value
          column := (((c << 6) + o) + (column.position << 2)) + 1
          IF
            column < 256
              SKIP
            TRUE
              column := 513 - column
          --}}}
          --{{{  determine row value
          row := ((first.row << 2) + r) + 1
          IF
            row < 256
              SKIP
            TRUE
              row := 513 - row
          --}}}
          value  :=  REAL32 ROUND( (row * column)  )
          Frame[max.frames-1][((r/\3)<<2)+o][r>>2][c] := value
  --}}}
  WHILE TRUE
    SEQ
      --{{{  get command and send up and accross
      fromPrev ? length::message
      PAR
        toUp ! length::message
        IF
          column.position < 15
            toNext ! length::message
          TRUE
            SKIP
      --}}}
      CASE command
        --{{{  c.set.target
        c.set.target
          SEQ
            SendFrame( fromUp, toDown, Frame[ params[0] ][ params[1] ],
                       params[2], params[3] )
            IF
              column.position = 15
                toPrev ! 0 (BYTE)
              TRUE
```

```
            BYTE synch :
            SEQ
              fromNext ? synch
              toPrev ! synch
      --}}}
      --{{{  c.target.row
      c.target.row
        GetTargetRow( Frame[ params[0] ][ params[1] ], params[2],
                      [params FROM 3 FOR 128] )
      --}}}
:
```

4.1.27. TrackDisplay.occ

```
PROC TrackDisplay ( CHAN OF ANY fromSP, toSP,
                                fromPrev, toPrev, fromNext, toNext )

  --{{{  libraries
  #INCLUDE  "s_header.inc"
  #INCLUDE  "g_header.inc"
  #INCLUDE  "crtc.inc"

  #USE  "convert.lib"
  #USE  "graphics.lib"
  --#USE  "extrio.lib"

  --}}}
  --{{{  display constants
  VAL  width          IS       640 :
  VAL  height         IS       480 :
  VAL  line.frequency IS     60000 :
  VAL  frame.rate     IS        90 :
  VAL  pixel.clock    IS  64000000 :
  VAL  interlace      IS     FALSE :
  --}}}
  --{{{  fonts
  #INCLUDE "sys6.inc"
  --}}}
  --{{{  place system variables
  [(20*65536)+1280] BYTE screen.map :
  PLACE screen.map AT screen.int.address :

  INT DisplayStart :
  PLACE DisplayStart AT DisplayStart.address :

  INT EventMode :
  PLACE EventMode AT EventMode.address :

  INT SysReady :
  PLACE SysReady AT (#00080000  >< (MOSTNEG INT)) >> 2 :

  INT Ready :
  PLACE Ready AT Ready.address :
  --}}}
  --{{{  set up multiple screens
  VAL screen.offset IS  [ #00000, #50000, #A0000, #F0000 ] :

  VAL screen.address IS [ #00000, #14000, #28000, #3C000 ] :
  --}}}
  --{{{  place Event channel
  CHAN OF ANY Event :
  PLACE Event AT 8 :
  --}}}
  --{{{  constants
  VAL  screen.width   IS  640 :
  VAL  screen.height  IS  480 :
  VAL  screen.size    IS  screen.width * screen.height :

  VAL  char.width     IS   18 :
  VAL  char.height    IS   33 :
  --}}}
  --{{{  procs
  --{{{  spectrum
  PROC spectrum ( CHAN OF ANY out )

    SEQ
      SEQ i = 0 FOR 64                          -- blue to red scale for 1 to 63
        set.colour( out, 0, i, i, 0, 31-(i>>1) )
```

```
    SEQ i = 0 FOR 64                          -- adding green and blue
      set.colour( out, 0, 64+i, 63, i, i )    --    for 64 to 127

    SEQ i = 128 FOR 128                       -- green for 128-255
      set.colour( out, 0, i, 0, 63, 0 )
    set.colour( out, 0, 0, 0, 0, 0 )          -- black for 0
    set.colour( out, 0, 128, 30, 30, 30 )     -- grey for 128
:
--}}}
--{{{  center.string
PROC center.string ( [] INT window, [] BYTE screen,
                     VAL INT cx, sy, VAL [] BYTE string,
                     VAL [] INT font )

  INT width :
  SEQ
    string.width( font, string, width )
    window[ w.cursor.y ] := sy
    window[ w.cursor.x ] := cx - (width >> 1)
    write.string( window, screen, string, font )
:
--}}}
--{{{  place.string
PROC place.string ( [] INT window, [] BYTE screen,
                    VAL INT sx, sy, VAL [] BYTE string,
                    VAL [] INT font )

  SEQ
    window[ w.cursor.y ] := sy
    window[ w.cursor.x ] := sx
    write.string( window, screen, string, font )
:
--}}}
--{{{  EventProc
PROC EventProc ( CHAN OF ANY Event, in )

  INT synch, address :
  WHILE TRUE
    SEQ
      in ? address
      Ready := 1
      Event ? synch
      DisplayStart := address
      Ready := 0
:
--}}}
--{{{  Buffer
PROC Buffer ( CHAN OF ANY in, out )

  INT temp :
  SEQ
    WHILE TRUE
      SEQ
        in ? temp
        out ! temp
:
--}}}
--{{{  set.text.window
PROC set.text.window ( [] INT window,
                       VAL [] BYTE string1, string2, VAL [] INT font,
                       VAL INT start.x, start.y, size.y )

  SEQ
    string.width( font, string1, window[ w.start.x ] )
    string.width( font, string2, window[ w.size.x ] )
    window[ w.start.x ] := window[ w.start.x ] + start.x
    window[ w.size.x  ] := window[ w.size.x  ] + 1
```

```
    window[ w.start.y ] := start.y
    window[ w.size.y  ] := size.y + 1
    window[ w.start ] := (screen.width * start.y) + window[ w.start.x ]
    window[ w.size  ] := screen.width * window[ w.size.y ]
    window[ w.pixels.line ] := screen.width
    window[ w.foreground.color ] := 255
    window[ w.background.color ] := 0
    window[ w.cursor.x ] := 0
    window[ w.cursor.y ] := 0
:
--}}}
--{{{  display.text
PROC display.text ( [] INT window, [] BYTE screen,
                    VAL [] BYTE text, VAL [] INT font )

  s IS [screen FROM window[ w.start ] FOR window[ w.size ]] :
  SEQ
    window[ w.cursor.x ] := 0
    window[ w.cursor.y ] := 0
    write.string( window, s, text, font )
:
--}}}
--{{{  place.numbers
PROC place.numbers ( [][] BYTE screen, [][][] BYTE char.array,
                     VAL [] BYTE string,
                     VAL INT start.x, start.y, size.x, size.y )

  INT x :
  SEQ
    x := start.x
    SEQ i = 0 FOR SIZE string
      VAL char IS INT string[i] :
      SEQ
        IF
          --{{{  display space character
          char = (INT ' ')
            VAL source IS char.array[11] :
            MOVE2D( source, 0, 0, screen, x, start.y, size.x, size.y )
          --}}}
          --{{{  display decimal character
          char = (INT '.')
            VAL source IS char.array[10] :
            MOVE2D( source, 0, 0, screen, x, start.y, size.x, size.y )
          --}}}
          --{{{  display number character
          TRUE
            VAL source IS char.array[char - (INT '0')] :
            MOVE2D( source, 0, 0, screen, x, start.y, size.x, size.y )
          --}}}
        x := x + size.x
:
--}}}
--{{{  MAX
REAL32 FUNCTION MAX ( VAL REAL32 a, b )

  REAL32 r :
  VALOF
    IF
      a > b
        r := a
      TRUE
        r := b
    RESULT r
:
--}}}
--{{{  MIN
REAL32 FUNCTION MIN ( VAL REAL32 a, b )
```

```
  REAL32 r :
  VALOF
    IF
      a < b
        r := a
      TRUE
        r := b
    RESULT r
:
--}}}
--{{{  IMAX
INT FUNCTION IMAX ( VAL INT a, b )

  INT r :
  VALOF
    IF
      a > b
        r := a
      TRUE
        r := b
    RESULT r
:
--}}}
--{{{  IMIN
INT FUNCTION IMIN ( VAL INT a, b )

  INT r :
  VALOF
    IF
      a < b
        r := a
      TRUE
        r := b
    RESULT r
:
--}}}
--}}}
--{{{  variables
[w.length] INT window :
[4][w.length] INT text.window :
[12][char.height][char.width] BYTE number :

CHAN OF ANY synch, synch1 :
--}}}
VAL font IS SYS6 :
SEQ
  --{{{  initialize
  set.B408( 0, 0, 0, 0, 0 )
  --{{{  set up B409
  set.timing( toPrev, width, height, line.frequency,
              frame.rate, pixel.clock, interlace )
  spectrum( toPrev )
  --}}}
  --{{{  generate display table for numbers
  [w.length] INT window :
  [12][char.width*char.height] BYTE n RETYPES number :
  SEQ
    SEQ i = 0 FOR 12
      SEQ j = 0 FOR char.width*char.height
        n[i][j] := 0 (BYTE)
    window := [ 0, char.width*char.height, char.width,
                0, 0, char.width, char.height, 255, 0, 0, 0 ]
    SEQ i = 0 FOR 10
      display.text( window, n[i], [ BYTE( i+(INT '0') )], font )
    display.text( window, n[10], ".", font )
    display.text( window, n[11], " ", font )
```

```
    --}}}
    --{{{  initial display
    [] INT int.screen RETYPES screen.map :
    SEQ i = 0 FOR (20*65536)/4
      int.screen[i] := 0

    window := [ 0, screen.size, screen.width, 0, 0,
                screen.width, screen.height, 255, 0, 0, 0 ]

    screen IS [screen.map FROM screen.offset[0] FOR screen.size ] :
    SEQ
      --{{{  draw first window
      draw.line( window, screen,  31, 111, 288, 111, 255(BYTE) )
      draw.line( window, screen, 288, 111, 288, 368, 255(BYTE) )
      draw.line( window, screen,  31, 368, 288, 368, 255(BYTE) )
      draw.line( window, screen,  31, 111,  31, 368, 255(BYTE) )
      --}}}
      --{{{  draw second window
      draw.line( window, screen, 351, 111, 608, 111, 255(BYTE) )
      draw.line( window, screen, 608, 111, 608, 368, 255(BYTE) )
      draw.line( window, screen, 351, 368, 608, 368, 255(BYTE) )
      draw.line( window, screen, 351, 111, 351, 368, 255(BYTE) )
      --}}}
      --{{{  draw text
      SEQ
        center.string( window, screen, 320, 1, "FPA Seeker Emulator", font )
        center.string( window, screen, 160, 70, "Raw FPA Image", font )
        center.string( window, screen, 480, 70, "Processed Image", font )

        place.string( window, screen, 0, 400, "Range: ", font )
        place.string( window, screen, 0, 440, "Sim Time: ", font )
        place.string( window, screen, 350, 400, "Frame Rate:", font )
        place.string( window, screen, 350, 440, "Frame Number:", font )

        set.text.window( text.window[0], "Range:", "0123456.789", font,  16,400,
32 )
        set.text.window( text.window[1], "Sim Time: ", "123.456", font,  16,440,
32 )
        set.text.window( text.window[2], "Frame Rate:   ", "123", font, 350,400,
32 )
        set.text.window( text.window[3], "Frame Number: ", "123", font, 350,440,
32 )

        --{{{  COMMENT place initial numbers
        --:::A  0 0
        --{{{  place initial numbers
        --[screen.height][screen.width] BYTE s2 RETYPES screen :
        --SEQ
          --place.numbers( s2, number, "     0.000", text.window[0][w.start.x],
          --               text.window[0][w.start.y], char.width, char.height )
          --place.numbers( s2, number, "  0.000", text.window[1][w.start.x],
          --               text.window[1][w.start.y], char.width, char.height )
          --place.numbers( s2, number, "  0", text.window[2][w.start.x],
          --               text.window[2][w.start.y], char.width, char.height )
          --place.numbers( s2, number, "  0", text.window[3][w.start.x],
          --               text.window[3][w.start.y], char.width, char.height )
        --}}}
        --}}}
      --}}}
      [screen.map FROM screen.offset[1] FOR screen.size] := screen
      [screen.map FROM screen.offset[2] FOR screen.size] := screen
      [screen.map FROM screen.offset[3] FOR screen.size] := screen
    --}}}
    set.B408( 0, 0, 0, 1, 0 )
    --}}}
    PRI PAR
      --{{{  synchronize display to event
```

```
      PAR
        EventProc( Event, synch1  )
        Buffer( synch, synch1 )
      --}}}
      --{{{  run system
      --{{{  variables
      INT load :
      INT frame :
      REAL32 range, time, rate :
      INT len :
      [12] BYTE string  string1 :

      --{{{  command variables
      BYTE length :
      [max.message] INT message :
      command IS message[0] :
      params IS [message FROM 1 FOR max.message-1] :
      [] REAL32 r.params RETYPES params :
      --}}}
      --}}}
      SEQ
        load := 0
        WHILE TRUE
          SEQ
            fromSP ? length::message
            IF
              --{{{  read graphics display
              command = c.read.graphics
                who IS params[0] :
                CASE who
                  track.display
                    --{{{
                    screen IS [screen.map FROM screen.offset[load] FOR screen.size
] :
                    [screen.height][screen.width] BYTE s2 RETYPES screen :
                    SEQ
                      toSP ! screen.height
                      SEQ i = 0 FOR screen.height
                        toSP ! screen.width::s2[i]
                    --}}}
                  display.palette
                    --{{{
                    SKIP
                    --}}}
                  ELSE
                    --{{{  image.display 0 or 1
                    INT number.of.transfers :
                    INT width :
                    [maxGraphicBuffer]BYTE graphicsBuffer :
                    SEQ
                      toNext   ! length::message
                      fromNext ? number.of.transfers
                      toSP     ! number.of.transfers
                      SEQ i = 0 FOR number.of.transfers
                        SEQ
                          fromNext ? width::graphicsBuffer
                          toSP     ! width::graphicsBuffer
                    --}}}
              --}}}
              --{{{  otherwise, normal processing
              TRUE
                SEQ
                  --{{{  place range, time, frame number, and frame rate on screen
                  screen IS [screen.map FROM screen.offset[load] FOR screen.size ]
:
                  range   IS  r.params[1] :
                  time    IS  r.params[2] :
```

```
                frame   IS  params[3]   :
                rate    IS  r.params[4] :
                SEQ
                  IF
                    frame >= 0
                      --{{{  display numbers
                      [screen.height][screen.width] BYTE s2 RETYPES screen :
                      SEQ
                        --{{{  range
                        range := MAX( 0.001(REAL32), MIN( 9999999.999(REAL32),
range ) )
                        REAL32TOSTRING( len, string, range, 7, 3 )
                        place.numbers( s2, number, [string FROM 1 FOR 11],
text.window[0][w.start.x],
                                       text.window[0][w.start.y], 16, 32 )
                        --}}}
                        --{{{  time
                        time := MAX( 0.001(REAL32), MIN( 999.999(REAL32), time )
)
                        REAL32TOSTRING( len, string, time, 3, 3 )
                        place.numbers( s2, number, [string FROM 1 FOR 7],
text.window[1][w.start.x],
                                       text.window[1][w.start.y], 16, 32 )
                        --}}}
                        --{{{  frame rate
                        rate := MAX( 0.0(REAL32), MIN( 999.0(REAL32), rate ) )
                        INTTOSTRING( len, string1, INT ROUND rate )
                        [string FROM 0 FOR 3] := "   "
                        [string FROM 3-len FOR len] := [string1 FROM 0 FOR len]
                        place.numbers( s2, number, [string FROM 0 FOR 3],
text.window[2][w.start.x],
                                       text.window[2][w.start.y], 16, 32 )
                        --}}}
                        --{{{  frame number
                        frame := IMAX( 0, IMIN( 999, frame ) )
                        INTTOSTRING( len, string1, frame )
                        [string FROM 0 FOR 3] := "   "
                        [string FROM 3-len FOR len] := [string1 FROM 0 FOR len]
                        place.numbers( s2, number, [string FROM 0 FOR 3],
text.window[3][w.start.x],
                                       text.window[3][w.start.y], 16, 32 )
                        --}}}
                      --}}}
                    TRUE
                      --{{{  clear the text windows
                      SEQ i = 0 FOR 4
                        win IS text.window[i] :
                        clear.window( win, [screen FROM win[ w.start ] FOR win[
w.size ]] )
                      --}}}
                --}}}
                --{{{  update screen
                IF
                  params[0] = 1
                    synch ! screen.address[load]
                  TRUE
                    DisplayStart := screen.address[load]
                --}}}
                load := (load + 1) /\ 3
              --}}}

      --}}}
:
```

4.1.28. XBar.occ

```
PROC XBar (CHAN OF ANY fromGuidance, toGuidance)
  #INCLUDE "s_header.inc"
  --{{{  hardware values
  VAL XbarBase IS #0800 :

  PORT OF INT xbar.data :
  PLACE xbar.data AT XbarBase :

  PORT OF INT xbar.status :
  PLACE xbar.status AT XbarBase + 1 :

  CHAN OF INT Event :
  PLACE Event AT 8 :
  --}}}
  --{{{  constants
  VAL local.c.guidance.initialize IS 0 :
  VAL local.c.guidance.run        IS 1 :
  VAL one.millisecond             IS 1000 :  -- ticks of high-priority clock
  --}}}
  --{{{  procs
  --{{{  INT.to.xbar   (VAL INT value)
  PROC INT.to.xbar (VAL INT value)
    INT test.status :
    SEQ
      xbar.status ? test.status
      WHILE ((test.status /\ #0001) = 1)
        xbar.status ? test.status
      xbar.data ! value
  :
  --}}}
  --{{{  INT.from.xbar (INT value)
  PROC INT.from.xbar (INT value)
    INT signal :
    SEQ
      Event ? signal
      xbar.data ? value
  :
  --}}}

  --{{{  vector.to.xbar   (VAL []INT value)
  PROC vector.to.xbar (VAL []INT value)
    SEQ i = 0 FOR SIZE(value)
      INT.to.xbar (value[i])
  :
  --}}}
  --{{{  vector.from.xbar ([]INT value)
  PROC vector.from.xbar ([]INT value)
    SEQ i = 0 FOR SIZE(value)
      INT.from.xbar (value[i])
  :
  --}}}
  --}}}
  --{{{  variables
  INT last.xbar.transfer :
  BOOL received.first.value :
  TIMER clock :
  --}}}
  PRI PAR
    SEQ
      --{{{  clear input buffer at start up
      INT dummy :
      xbar.data ? dummy
      --}}}
      WHILE TRUE
```

```
        INT32 command :
        SEQ
          fromGuidance ? command
          CASE (INT command)
            --{{{  initialize
            c.guidance.initialize
              INT dummy :
              SEQ
                received.first.value := FALSE
            --}}}
            --{{{  run
            c.guidance.run
              [6]INT data.vector : --REAL32 time, shift.x, shift.y,
              SEQ
                --IF
                --  received.first.value
                --    SEQ   -- force crossbar transfers to execute at real-time
rates
                --      clock ? AFTER last.xbar.transfer PLUS one.millisecond
                --  TRUE
                --    received.first.value := TRUE
                vector.from.xbar (data.vector)
                clock ? last.xbar.transfer
                toGuidance ! data.vector
            --}}}
    SKIP
:
```

4.2. Include Files

4.2.1. CRTC.inc

```
--{{{  crtc
PROTOCOL CRTC
  CASE
    crtc.init       ;  INT16; INT16; INT32; INT16; INT32; BOOL
    crtc.color      ;  INT16; INT16; INT16; INT16; INT16
    crtc.initLUT    ;  INT16; INT16
    crtc.stop
:

VAL channel.A IS 0 (INT16):
VAL channel.B IS 1 (INT16):
VAL channel.C IS 2 (INT16):
--}}}
```

4.2.2. G_Header.inc

```
`--{{{  system constants
VAL bpw       IS 4 :
VAL bpw.shift IS 2 :
VAL mint      IS MOSTNEG INT :

VAL screen.int.address      IS (#80100000   >< mint) >> bpw.shift :
VAL DisplayStart.address    IS (#00000000   >< mint) >> bpw.shift :
VAL InterlaceEnable.address IS (#000C0000   >< mint) >> bpw.shift :
VAL EventMode.address       IS (#00100000   >< mint) >> bpw.shift :
VAL OutputEnable.address    IS (#00140000   >< mint) >> bpw.shift :
VAL Ready.address           IS (#00040000   >< mint) >> bpw.shift :
--}}}
--{{{  window constants
VAL w.start             IS    0 :
VAL w.size              IS    1 :
VAL w.pixels.line       IS    2 :
VAL w.start.x           IS    3 :
VAL w.start.y           IS    4 :
VAL w.size.x            IS    5 :
VAL w.size.y            IS    6 :
VAL w.foreground.color  IS    7 :
VAL w.background.color  IS    8 :
VAL w.cursor.x          IS    9 :
VAL w.cursor.y          IS   10 :
VAL w.length            IS   11 :
--}}}
--{{{  text drawing modes
VAL normal.mode       IS 0 :
VAL foreground.mode   IS 4 :
VAL and.mode          IS 1 :
VAL or.mode           IS 2 :
VAL xor.mode          IS 3 :
--}}}
--{{{  window decisions
VAL in.range        IS 0 :
VAL part.inrange    IS 1 :
VAL not.inrange     IS 2 :
--}}}
--{{{  font file format
VAL dfVersion.p         IS 0 :    --2
VAL dfSize.p            IS 2 :    --4
VAL dfCopyright.p       IS 6 :    --60
VAL dfType.p            IS 66 :   --2
VAL dfPoints.p          IS 68 :   --2
VAL dfVertRes.p         IS 70 :   --2
VAL dfHorizRes.p        IS 72 :   --2
VAL dfAscent.p          IS 74 :   --2
VAL dfInternalLeading.p IS 76 :   --2
VAL dfExternalLeading.p IS 78 :   --2
VAL dfItalic.p          IS 80 :   --1
VAL dfUnderline.p       IS 81 :   --1
VAL dfStrikeOut.p       IS 82 :   --1
VAL dfWeight.p          IS 83 :   --2
VAL dfCharSet.p         IS 85 :   --1
VAL dfPixWidth.p        IS 86 :   --2
VAL dfPixHeight.p       IS 88 :   --2
VAL dfPitchAndFamily.p  IS 90 :   --1
VAL dfAvgWidth.p        IS 91 :   --2
VAL dfMaxWidth.p        IS 93 :   --2
VAL dfFirstChar.p       IS 95 :   --1
VAL dfLastChar.p        IS 96 :   --1
VAL dfDefaultChar.p     IS 97 :   --1
VAL dfBreakChar.p       IS 98 :   --1
VAL dfWidthBytes.p      IS 99 :   --2
```

```
VAL dfDevice.p          IS 101 :  --4
VAL dfFace.p            IS 105 :  --4
VAL dfBitsPointer.p     IS 109 :  --4
VAL dfBitsOffset.p      IS 113 :  --4
VAL CharTable.p         IS 118 :  --
--}}}
--{{{  font specification offsets
VAL  fs.PixWidth     IS  0 :
VAL  fs.PixHeight    IS  1 :
VAL  fs.FirstChar    IS  2 :
VAL  fs.LastChar     IS  3 :
VAL  fs.BitsOffset   IS  4 :
VAL  fs.size         IS  5 :
--}}}
```

4.2.3. S_Header.inc

```
--{{{  misc. constants
VAL  max.message     IS  240 :
VAL  max.frames      IS  232 :
VAL  max.sim.frames  IS 2000 :
--}}}
--{{{  commands
--  Controller commands                    -- parameters for commands
VAL  c.start.frame             IS    0 :  -- frame
VAL  c.run.single              IS    1 :
VAL  c.run.continuous          IS    2 :
VAL  c.frame.rate              IS    3 :  -- start; frames; [frames] data
VAL  c.frame.time              IS    4 :  -- start; frames; [frames] data
VAL  c.frame.range             IS    5 :  -- start; frames; [frames] data
VAL  c.sim.position            IS    6 :  -- variable; start; frames; [] data
VAL  c.sim.start.frames        IS    7 :  -- first.frame; last.frame
VAL  c.test.controller         IS    8 :
VAL  c.restart                 IS    9 :
VAL  c.set.calibration         IS   10 :  -- back.level0; back.level1;
                                          -- sp.level0; sp.level1

--  GTSEI commands
VAL  c.set.crossbar            IS  256 :  -- shift

--  Target commands
VAL  c.set.target              IS  512 :  -- frame;subpixel;row.shift;col.shift
VAL  c.target.row              IS  513 :  -- frame;subpixel;row;[128]data
VAL  c.test.target             IS  514 :

--  Background commands
VAL  c.set.background          IS  768 :  -- frame
VAL  c.background.row          IS  769 :  -- frame; row; [128] data
VAL  c.gain.row                IS  770 :  -- row; [128] data
VAL  c.offset.row              IS  771 :  -- row; [128] data
VAL  c.global.scale            IS  772 :  -- scale
VAL  c.test.background         IS  773 :
VAL  c.calibration.frame       IS  774 :  -- calibration.level

--  Signal Processing commands
VAL  c.sp.frame                IS 1024 :  -- calibration.frame; calibration.level;
                                          -- lower.threshold; upper.threshold;
                                          -- frame.range; frame.time;
                                          -- frame.number; frame.rate;
                                          -- [6]seeker.target.position
--  Guidance commands
VAL  c.guidance.initialize     IS 1280 :
VAL  c.guidance.set.mode       IS 1281 :  -- mode
VAL  c.guidance.run            IS 1282 :  -- FPA; frame.range; frame.time;
                                          -- column.hot.spot; row.hot.spot;
                                          -- [3]seeker.position;
                                          -- [3]target.position

--  Track Display commands
VAL  c.display.info            IS 1536 :  -- FPA; frame.range; frame.time;
                                          -- frame.number; frame.rate

-- command for reading graphics buffers or palette
VAL  c.read.graphics           IS 2000 :  -- display
--}}}
--{{{  commands for continuous frame operation
VAL  cc.exit          IS  0 :
VAL  cc.shift.image   IS  1 :  -- column.shift; row.shift
--}}}
--{{{  variables in position
VAL  p.seeker.x    IS  0 :
```

```
VAL  p.seeker.y     IS  1 :
VAL  p.seeker.z     IS  2 :
VAL  p.target.x     IS  3 :
VAL  p.target.y     IS  4 :
VAL  p.target.z     IS  5 :
VAL  p.length       IS  6 :
--}}}
--{{{  guidance mode constants
VAL  gm.none       IS   0 :
VAL  gm.external   IS   1 :
VAL  gm.internal   IS   2 :
--}}}
--{{{  graphics read constants
VAL image.display.0 IS 0 :
VAL image.display.1 IS 1 :
VAL track.display   IS 2 :
VAL display.palette IS 3 :

VAL maxGraphicBuffer IS 640 :
--}}}
```

4.2.4. Sys6.inc

```
VAL SYS6 IS [#44DA0200,#6F430000,#69727970,#20746867,
#20296328,#37383931,#6F535A20,#43207466,#6F70726F,#69746172,#6E6F    ,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#12C0008 ,
#18012C  ,#2       ,#90000000,#10FF01  ,#10300020,#1001000 ,#1F2DFF  ,
#47602   ,#4A800   ,#0       ,#4DA00   ,#100000  ,#1004DA  ,#10051A  ,
#10055A  ,#10059A  ,#1005DA  ,#10061A  ,#10065A  ,#10069A  ,#1006DA  ,
#10071A  ,#10075A  ,#10079A  ,#1007DA  ,#10081A  ,#10085A  ,#10089A  ,
#1008DA  ,#10091A  ,#10095A  ,#10099A  ,#1009DA  ,#100A1A  ,#100A5A  ,
#100A9A  ,#100ADA  ,#100B1A  ,#100B5A  ,#100B9A  ,#100BDA  ,#100C1A  ,
#100C5A  ,#100C9A  ,#100CDA  ,#100D1A  ,#100D5A  ,#100D9A  ,#100DDA  ,
#100E1A  ,#100E5A  ,#100E9A  ,#100EDA  ,#100F1A  ,#100F5A  ,#100F9A  ,
#100FDA  ,#10101A  ,#10105A  ,#10109A  ,#1010DA  ,#10111A  ,#10115A  ,
#10119A  ,#1011DA  ,#10121A  ,#10125A  ,#10129A  ,#1012DA  ,#10131A  ,
#10135A  ,#10139A  ,#1013DA  ,#10141A  ,#10145A  ,#10149A  ,#1014DA  ,
#10151A  ,#10155A  ,#10159A  ,#1015DA  ,#10161A  ,#1016SA  ,#10169A  ,
#1016DA  ,#10171A  ,#10175A  ,#10179A  ,#1017DA  ,#10181A  ,#10185A  ,
#10189A  ,#1018DA  ,#10191A  ,#10195A  ,#10199A  ,#1019DA  ,#101A1A  ,
#101A5A  ,#101A9A  ,#101ADA  ,#101B1A  ,#101B5A  ,#101B9A  ,#101BDA  ,
#101C1A  ,#101C5A  ,#101C9A  ,#101CDA  ,#101D1A  ,#101D5A  ,#101D9A  ,
#101DDA  ,#101E1A  ,#101E5A  ,#101E9A  ,#101EDA  ,#101F1A  ,#101F5A  ,
#101F9A  ,#101FDA  ,#10201A  ,#10205A  ,#10209A  ,#1020DA  ,#10211A  ,
#10215A  ,#10219A  ,#1021DA  ,#10221A  ,#10225A  ,#10229A  ,#1022DA  ,
#10231A  ,#10235A  ,#10239A  ,#1023DA  ,#10241A  ,#10245A  ,#10249A  ,
#1024DA  ,#10251A  ,#10255A  ,#10259A  ,#1025DA  ,#10261A  ,#10265A  ,
#10269A  ,#1026DA  ,#10271A  ,#10275A  ,#10279A  ,#1027DA  ,#10281A  ,
#10285A  ,#10289A  ,#1028DA  ,#10291A  ,#10295A  ,#10299A  ,#1029DA  ,
#102A1A  ,#102A5A  ,#102A9A  ,#102ADA  ,#102B1A  ,#102B5A  ,#102B9A  ,
#102BDA  ,#102C1A  ,#102C5A  ,#102C9A  ,#102CDA  ,#102D1A  ,#102D5A  ,
#102D9A  ,#102DDA  ,#102E1A  ,#102E5A  ,#102E9A  ,#102EDA  ,#102F1A  ,
#102F5A  ,#102F9A  ,#102FDA  ,#10301A  ,#10305A  ,#10309A  ,#1030DA  ,
#10311A  ,#10315A  ,#10319A  ,#1031DA  ,#10321A  ,#10325A  ,#10329A  ,
#1032DA  ,#10331A  ,#10335A  ,#10339A  ,#1033DA  ,#10341A  ,#10345A  ,
#10349A  ,#1034DA   #10351A  ,#10355A  ,#10359A  ,#1035DA  ,#10361A  ,
#10365A  ,#10369A  ,#1036DA  ,#10371A  ,#10375A  ,#10379A  ,#1037DA  ,
#10381A  ,#10385A  ,#10389A  ,#1038DA  ,#10391A  ,#10395A  ,#10399A  ,
#1039DA  ,#103A1A  ,#103A5A  ,#103A9A  ,#103ADA  ,#103B1A  ,#103B5A  ,
#103B9A  ,#103BDA  ,#103C1A  ,#103C5A  ,#103C9A  ,#103CDA  ,#103D1A  ,
#103D5A  ,#103D9A  ,#103DDA  ,#103E1A  ,#103E5A  ,#103E9A  ,#103EDA  ,
#103F1A  ,#103F5A  ,#103F9A  ,#103FDA  ,#10401A  ,#10405A  ,#10409A  ,
#1040DA  ,#10411A  ,#10415A  ,#10419A  ,#1041DA  ,#10421A  ,#10425A  ,
#10429A  ,#1042DA  ,#10431A  ,#10435A  ,#10439A  ,#1043DA  ,#10441A  ,
#10445A  ,#449A    ,#0       ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,
#74737953,#36206D65,#34206400,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#1C1E0F07,
#76763838,#70707676,#77777070,#1E1C3B3B,#70F     ,#0       ,#0       ,
#3878F0E0,#6E6E1C1C,#E0E6E6E ,#EEEE0E0E,#7838DCDC,#E0F0    ,#0       ,
#0       ,#1F1F0F07,#79793F3F,#7F7F7979,#78787F7F,#1F1F3C3C,#70F     ,
#0       ,#0       ,#F8F8F0E0,#9E9EFCFC,#FEFE9E9E,#1E1EFEFE,#F8F83C3C,
#E0F0    ,#0       ,#0       ,#7F7F3E1C,#7F7F7F7F,#1F1F3F3F,#7070F0F ,
#1010303 ,#0       ,#0       ,#0       ,#7F7F3E1C,#FFFFFFFF,#FCFCFEFE,
#F0F0F8F8,#C0C0E0E0,#8080    ,#0       ,#0       ,#1010000 ,#7070303 ,
#1F1F0F0F,#7070F0F ,#1010303 ,#0       ,#0       ,#0       ,#C0C08080,
#F0F0E0E0,#FCFCF8F8,#F0F0F8F8,#C0C0E0E0,#8080    ,#0       ,#0       ,
#7070301 ,#3030707 ,#7F7F7D39,#397D7F7F,#1010101 ,#303     ,#0       ,
#0       ,#F0F0E0C0,#E0E0F0F0,#FFFFDFCE,#CEDFFFFF,#C0C0C0C0,#E0E0    ,
#0       ,#0       ,#1010000 ,#7070303 ,#1F1F0F0F,#1D3D3F3F,#1010101 ,
#303     ,#0       ,#0       ,#C0C08080,#F0F0E0E0,#FCFCF8F8,#DCDEFEFE,
#C0C0C0C0,#E0E0    ,#0       ,#0       ,#0       ,#0       ,#7070703 ,
#3070707 ,#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,
#E0E0E0C0,#C0E0E0E0,#0       ,#0       ,#0       ,#0       ,#FFFFFFFF,
#FFFFFFFF,#F8F8F8FC,#FCF8F8F8,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFF    ,
#FFFFFFFF,#FFFFFFFF,#1F1F1F3F,#3F1F1F1F,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,
#FFFF    ,#0       ,#0       ,#1C1E0F07,#38383838,#70F1E1C ,#0       ,
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#0       ,#0       ,#0       ,#0       ,#3878F0E0,#1C1C1C1C,#E0F07838,
#0       ,#0       ,#0       ,#FFFFFFFF,#FFFFFFFF,#E3E1F0F8,#C7C7C7C7,
#F8F0E1E3,#FFFFFFFF,#FFFFFFFF,#FFFF    ,#FFFFFFFF,#FFFFFFFF,#C7870F1F,
#E3E3E3E3,#1F0F87C7,#FFFFFFFF,#FFFFFFFF,#FFFF    ,#0       ,#303     ,
#1F0F0000,#70703838,#38387070,#F1F     ,#0       ,#0       ,#0       ,
#3E1EFEFE,#E6E67676,#7070E0E0,#E0E07070,#80C0    ,#0       ,#0       ,
#E0E0703 ,#1C1C1C1C,#3070E0E ,#1010101 ,#1010707 ,#101     ,#0       ,
#0       ,#3838F0E0,#1C1C1C1C,#E0F03838,#C0C0C0C0,#C0C0F0F0,#C0C0    ,
#0       ,#0       ,#3030303 ,#3030303 ,#3030303 ,#1F0F0303,#F1F3F3F ,
#0       ,#0       ,#0       ,#9C9CF8F0,#80808E8E,#80808080,#80808080,
#808080  ,#0       ,#0       ,#0       ,#7070707 ,#7070707 ,#7070707 ,
#3F1F0707, `E3F7F7F,#0       ,#0       ,#0       ,#707FFFF ,#707FFFF ,
#7070707 ,#7070707 ,#7F7F3F1F,#1E3F    ,#0       ,#0       ,#39390101,
#70F1D1D ,#7C7C1C0E,#F070E1C ,#39391D1D,#101     ,#0       ,#0       ,
#CECEC0C0,#F0F8DCDC,#1F1F1C38,#F8F0381C,#CECEDCDC,#C0C0    ,#0       ,
#0       ,#3E3C3830,#3F3F3F3F,#3F3F3F3F,#3F3F3F3F,#3C3E3F3F,#3038    ,
#0       ,#0       ,#0       ,#E0C08000,#FCFCF8F0,#C0E0F0F8,#80      ,
#0       ,#0       ,#0       ,#0       ,#7030100 ,#3F3F1F0F,#3070F1F ,
#1       ,#0       ,#0       ,#0       ,#7C3C1C0C,#FCFCFCFC,#FCFCFCFC,
#FCFCFCFC,#3C7CFCFC,#C1C     ,#0       ,#0       ,#1010000 ,#7070303 ,
#1010F0F ,#F0F0101 ,#3030707 ,#101     ,#0       ,#0       ,#C0C08080,
#F0F0E0E0,#C0C0F8F8,#F8F8C0C0,#E0E0F0F0,#8080C0C0,#0       ,#0       ,
#3C3C3C18,#3C3C3C3C,#183C3C3C,#18181818,#3C180000,#183C    ,#0       ,
#0       ,#3C3C3C18,#3C3C3C3C,#183C3C3C,#18181818,#3C180000,#183C    ,
#0       ,#0       ,#737B3F1F,#73737373,#7B737373,#3031F3F ,#3030303 ,
#303     ,#0       ,#0       ,#9C9CFFFF,#9C9C9C9C,#9C9C9C9C,#9C9C9C9C,
#9C9C9C9C,#9C9C    ,#0       ,#0       ,#383C1F0F,#E1C3838 ,#1C1C0F07,
#70F     ,#1E1C0000,#70F     ,#0       ,#0       ,#3878F0E0,#0       ,
#3838F0E0,#3870E0F0,#3C1C1C1C,#F0F8    ,#0       ,#0       ,#0       ,
#0       ,#0       ,#F0F0F0F ,#F0F    ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#F0F0F0F0,#F0F0    ,#0       ,#0       ,
#0       ,#1010000 ,#7070303 ,#1010F0F ,#F0F0101 ,#3030707 ,#1F000101,
#0       ,#0       ,#C0C08080,#F0F0E0E0,#C0C0F8F8,#F8F8C0C0,#E0E0F0F0,
#FC80C0C0,#0       ,#0       ,#1010000 ,#7070303 ,#1010F0F ,#1010101 ,
#1010101 ,#101     ,#0       ,#0       ,#C0C08080,#F0F0E0E0,#C0C0F8F8,
#C0C0C0C0,#C0C0C0C0,#C0C0    ,#0       ,#0       ,#1010000 ,#1010101 ,
#1010101 ,#F0F0101 ,#3030707 ,#101     ,#0       ,#0       ,#C0C00000,
#C0C0C0C0,#C0C0C0C0,#F8F8C0C0,#E0E0F0F0,#8080C0C0,#0       ,#0       ,
#0       ,#1010101 ,#7F7F0101,#1010101 ,#101     ,#0       ,#0       ,
#0       ,#0       ,#F0E0C080,#FEFEFCF8,#E0F0F8FC,#80C0    ,#0       ,
#0       ,#0       ,#0       ,#F070301 ,#7F7F3F1F,#70F1F3F ,#103     ,
#0       ,#0       ,#0       ,#0       ,#80808080,#FEFE8080,#80808080,
#8080    ,#0       ,#0       ,#0       ,#0       ,#38380000,#38383838,
#3F3F    ,#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,
#0       ,#FCFC    ,#0       ,#0       ,#0       ,#0       ,#0       ,
#E060000 ,#7F7F3E1E,#60E1E3E ,#0       ,#0       ,#0       ,#0       ,
#0       ,#70600000,#FEFE7C78,#6070787C,#0       ,#0       ,#0       ,
#0       ,#0       ,#1010000 ,#7070303 ,#1F1F0F0F,#3F3F    ,#0       ,
#0       ,#0       ,#0       ,#80800000,#E0E0C0C0,#F8F8F0F0,#FCFC    ,
#0       ,#0       ,#0       ,#0       ,#3F3F0000,#F0F1F1F ,#3030707 ,
#101     ,#0       ,#0       ,#0       ,#0       ,#FCFC0000,#F0F0F8F8,
#C0C0E0E0,#8080    ,#0       ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,
#F0F0F07 ,#F0F0F0F ,#70F0F0F ,#7070707 ,#F070000 ,#70F     ,#0       ,
#0       ,#80808000,#80808080,#808080  ,#0       ,#80000000,#80      ,
#0       ,#0       ,#E0E0E0E ,#60606   ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#70707070,#606060  ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#E0E0000 ,#3F3F0E0E,#E0E0E0E ,
#3F3F0E0E,#E0E0E0E ,#0       ,#0       ,#0       ,#70700000,#FCFC7070,
#70707070,#FCFC7070,#70707070,#0       ,#0       ,#0       ,#1010101 ,
#393D1F0F,#F1F3D39 ,#1010101 ,#1011F1F ,#101     ,#0       ,#0       ,
#C0C0C0C0,#C0C0FCFC,#FCF8C0C0,#DECECEDE,#C0C0F8FC,#C0C0    ,#0       ,
#0       ,#33333F1E,#1E3F    ,#1010000 ,#7070303 ,#1C1C0E0E,#3838    ,
#0       ,#0       ,#1C1C0E0E,#70703838,#C0C0E0E0,#8080    ,#66667E3C,
#3C7E    ,#0       ,#0       ,#1C1C0F07,#1C1C1C1C,#70F1D1D ,#713B1F0F,
#38707070,#F1F     ,#0       ,#0       ,#E0E0C080,#E0E0E0E0,#8080C0C0,
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#F89C0E00,#F870F0F0,#8EDE    ,#0        ,#0        ,#1030301 ,#3030100 ,
#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,#E0E0E0C0,
#80C0E0   ,#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,
#7070301 ,#7070707 ,#7070707 ,#7070707 ,#7070707 ,#103     ,#0        ,
#0        ,#80F0F0  ,#0        ,#0        ,#0        ,#80000000,#F0F0     ,
#0        ,#0        ,#707     ,#0        ,#0        ,#0        ,#0        ,
#707      ,#0        ,#0        ,#70F0E0C0,#70707070,#70707070,#70707070,
#F0707070,#C0E0     ,#0        ,#0        ,#0        ,#E0E1C1C ,#7F7F0707,
#E0E0707 ,#1C1C     ,#0        ,#0        ,#0        ,#0        ,#70703838,
#FEFEE0E0,#7070E0E0,#3838     ,#0        ,#0        ,#0        ,#0        ,
#3030000 ,#3F3F0303,#3030303 ,#0        ,#0        ,#0        ,#0        ,
#0        ,#80800000,#F8F88080,#80808080,#0        ,#0        ,#0        ,
#0        ,#0        ,#0        ,#0        ,#0        ,#F070000 ,#703070F ,
#C0E      ,#0        ,#0        ,#0        ,#0        ,#0        ,#80000000,
#8080E0   ,#0        ,#0        ,#0        ,#0        ,#3F3F0000,#0        ,
#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,#F8F80000,
#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#F070000 ,#70F      ,#0        ,#0        ,#0        ,
#0        ,#0        ,#0        ,#80000000,#80       ,#0        ,#0        ,
#0        ,#0        ,#1010000 ,#7070303 ,#1C1C0E0E,#3838     ,#0        ,
#0        ,#1C1C0E0E,#70703838,#C0C0E0E0,#8080     ,#0        ,#0        ,
#0        ,#0        ,#383C1F0F,#38383838,#39393838,#3E3E3B3B,#3C383C3C,
#F1F      ,#0        ,#0        ,#1C3CF8F0,#7C7C3C3C,#9C9CDCDC,#1C1C1C1C,
#3C1C1C1C,#F0F8     ,#0        ,#0        ,#F0F0703 ,#1010101 ,#1010101 ,
#1010101 ,#1010101 ,#1F1F     ,#0        ,#0        ,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#FCFC     ,#0        ,#0        ,#1C1E0F07,
#0        ,#0        ,#7030100 ,#38381C0E,#3F3F     ,#0        ,#0        ,
#1C3CF8F0,#1C1C1C1C,#70381C1C,#80C0E0   ,#0        ,#FCFC     ,#0        ,
#0        ,#1C1E0F07,#0        ,#3030000 ,#0        ,#1E1C0000,#70F      ,
#0        ,#0        ,#1C3CF8F0,#1C1C1C1C,#F0F0381C,#1C1C1C38,#3C1C1C1C,
#F0F8     ,#0        ,#0        ,#3030100 ,#E0E0707 ,#38381C1C,#7F7F7070,
#0        ,#0        ,#0        ,#0        ,#F0F0F0F0,#70707070,#70707070,
#FEFE7070,#70707070,#7070     ,#0        ,#0        ,#38383F3F,#38383838,
#3F3F     ,#0        ,#3C380000,#F1F      ,#0        ,#0        ,#F8F8     ,
#0        ,#1C3CF8F0,#1C1C1C1C,#3C1C1C1C,#F0F8     ,#0        ,#0        ,
#383C1F0F,#38383838,#3F3F3838,#38383838,#3C383838,#F1F      ,#0        ,
#0        ,#3878F0E0,#0        ,#F8F00000,#1C1C1C3C,#3C1C1C1C,#F0F8     ,
#0        ,#0        ,#383F3F  ,#0        ,#0        ,#0        ,#3030101 ,
#303      ,#0        ,#0        ,#1C1CFCFC,#1C1C1C1C,#38381C1C,#E0E07070,
#8080C0C0,#8080     ,#0        ,#0        ,#383C1F0F,#38383838,#F0F1C38 ,
#3838381C,#3C383838,#F1F      ,#0        ,#0        ,#1C3CF8F0,#1C1C1C1C,
#F0F0381C,#1C1C1C38,#3C1C1C1C,#F0F8     ,#0        ,#0        ,#383C1F0F,
#38383838,#F1F3C38 ,#0        ,#1C1C0000,#70F      ,#0        ,#0        ,
#1C3CF8F0,#1C1C1C1C,#FCFC1C1C,#1C1C1C1C,#3C1C1C1C,#F0F8     ,#0        ,
#0        ,#0        ,#0        ,#70F0F07 ,#0        ,#F070000 ,#70F      ,
#0        ,#0        ,#0        ,#0        ,#808000   ,#0        ,#80000000,
#80       ,#0        ,#0        ,#0        ,#0        ,#70F0F07 ,#0        ,
#F070000 ,#703070F ,#C0E      ,#0        ,#0        ,#0        ,#808000   ,
#0        ,#80000000,#808080   ,#0        ,#0        ,#0        ,#1010000 ,
#7070303 ,#7070E0E ,#1010303 ,#0        ,#0        ,#0        ,#0        ,
#C0C0E0E0,#8080     ,#0        ,#C0C08080,#E0E0     ,#0        ,#0        ,
#0        ,#0        ,#3F3F     ,#3F3F0000,#0        ,#0        ,#0        ,
#0        ,#0        ,#0        ,#FCFC     ,#FCFC0000,#0        ,#0        ,
#0        ,#0        ,#0        ,#3030707 ,#101      ,#0        ,#3030101 ,
#707      ,#0        ,#0        ,#0        ,#80800000,#E0E0C0C0,#E0E07070,
#8080C0C0,#0        ,#0        ,#0        ,#1C1E0F07,#0        ,#1000000 ,
#3030303 ,#7030000 ,#307      ,#0        ,#0        ,#1C3CF8F0,#1C1C1C1C,
#C0E07038,#80808080,#C0800000,#80C0     ,#0        ,#0        ,#1C1E0F07,
#39383838,#3B3B3B3B,#38393B3B,#1E1C3838,#70F      ,#0        ,#0        ,
#3878F0E0,#FCFC1C1C,#9C9C9C9C,#FCFC9C9C,#0        ,#F0F0     ,#0        ,
#0        ,#E0E0703 ,#1C1C1C1C,#38383838,#38383F3F,#38383838,#3838     ,
#0        ,#0        ,#7070E0C0,#38383838,#1C1C1C1C,#1C1CFCFC,#1C1C1C1C,
#1C1C     ,#0        ,#0        ,#38383F3F,#38383838,#3F3F3838,#38383838,
#38383838,#3F3F     ,#0        ,#0        ,#3870E0C0,#38383838,#E0C0E070,
#1C1C3870,#381C1C1C,#E0F0     ,#0        ,#0        ,#383C1F0F,#38383838,
#38383838,#38383838,#3C383838,#F1F      ,#0        ,#0        ,#1C3CF8F0,
#0        ,#0        ,#0        ,#3C1C0000,#F0F8     ,#0        ,#0        ,
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#38383F3F,#38383838,#38383838,#38383838,#38383838,#3F3F     ,#0        ,
#0        ,#1C3CF8F0,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#3C1C1C1C,#F0F8     ,
#0        ,#0        ,#1C1C1F1F,#1C1C1C1C,#1F1F1C1C,#1C1C1C1C,#1C1C1C1C,
#1F1F     ,#0        ,#0        ,#FCFC     ,#0        ,#F0F00000,#0        ,
#0        ,#FCFC     ,#0        ,#0        ,#1C1C1F1F,#1C1C1C1C,#1F1F1C1C,
#1C1C1C1C,#1C1C1C1C,#1C1C     ,#0        ,#0        ,#FCFC     ,#0        ,
#F0F00000,#0        ,#0        ,#0        ,#0        ,#0        ,#383C1F0F,
#38383838,#38383838,#38383838,#3C383838,#F1F      ,#0        ,#0        ,
#3878F0E0,#0        ,#FCFC0000,#1C1C1C1C,#1C1C1C1C,#FCFC     ,#0        ,
#0        ,#38383838,#38383838,#3F3F3838,#38383838,#38383838,#3838     ,
#0        ,#0        ,#1C1C1C1C,#1C1C1C1C,#FCFC1C1C,#1C1C1C1C,#1C1C1C1C,
#1C1C     ,#0        ,#0        ,#1010F0F ,#1010101 ,#1010101 ,#1010101 ,
#1010101 ,#F0F      ,#0        ,#0        ,#C0C0F8F8,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#F8F8     ,#0        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#1E1C1C00,#70F      ,#0        ,#0        ,#1C1C1C1C,
#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#3C1C1C1C,#F0F8     ,#0        ,#0        ,
#38383838,#39393838,#3F3F3B3B,#39393B3B,#38383838,#3838     ,#0        ,
#0        ,#70703838,#C0C0E0E0,#8080     ,#C0C08080,#7070E0E0,#3838     ,
#0        ,#0        ,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,
#1F1F     ,#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,
#0        ,#FCFC     ,#0        ,#0        ,#70706060,#7C7C7878,#77777E7E,
#71717373,#70707070,#7070     ,#0        ,#0        ,#7070303 ,#1F1F0F0F,
#77773F3F,#C7C7E7E7,#7078787 ,#707      ,#0        ,#0        ,#3C3C3838,
#3F3F3E3E,#39393B3B,#38383838,#38383838,#3838     ,#0        ,#0        ,
#1C1C1C1C,#1C1C1C1C,#DCDC9C9C,#7C7CFCFC,#1C1C3C3C,#1C1C     ,#0        ,
#0        ,#383C1F0F,#38383838,#38383838,#38383838,#3C383838,#F1F      ,
#0        ,#0        ,#1C3CF8F0,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#3C1C1C1C,
#F0F8     ,#0        ,#0        ,#38383F3F,#38383838,#3F3F3838,#38383838,
#38383838,#3838     ,#0        ,#0        ,#1C3CF8F0,#1C1C1C1C,#F0F83C1C,
#0        ,#0        ,#0        ,#0        ,#0        ,#1C1E0F07,#38383838,
#38383838,#38383838,#1E1C3839,#70F      ,#0        ,#0        ,#3878F0E0,
#1C1C1C1C,#1C1C1C1C,#DC1C1C1C,#F878FCDC,#9CDC     ,#0        ,#0        ,
#38383F3F,#38383838,#3F3F3838,#38383939,#38383838,#3838     ,#0        ,
#0        ,#1C3CF8F0,#1C1C1C1C,#F0F83C1C,#E0E0C0C0,#38387070,#1C1C     ,
#0        ,#0        ,#381C0F07,#1C383838,#103070E ,#0        ,#3C380000,
#F1F      ,#0        ,#0        ,#1C3CF8F0,#0        ,#C0800000,#1C3870E0,
#381C1C1C,#E0F0     ,#0        ,#0        ,#3038F3F ,#3030303 ,#3030303 ,
#3030303 ,#3030303 ,#303      ,#0        ,#0        ,#8080F8F8,#80808080,
#80808080,#80808080,#80808080,#8080 ,#0        ,#0        ,#38383838,
#38383838,#38383838,#38383838,#1C383838,#70F      ,#0        ,#0        ,
#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#381C1C1C,#E0F0     ,#0        ,
#0        ,#38383838,#38383838,#38383838,#E0E1C1C ,#3030707 ,#101      ,
#0        ,#0        ,#E0E0E0E ,#E0E0E0E ,#E0E0E0E ,#38381C1C,#E0E07070,
#C0C0     ,#0        ,#0        ,#70707070,#70707070,#39393939,#3B3B3B3B,
#1E1E1F1F,#1C1C     ,#0        ,#0        ,#7070707 ,#87870707,#CECECECE,
#FEFEEEEE,#3C3C7C7C,#1C1C     ,#0        ,#0        ,#1C1C3838,#7070E0E ,
#1010303 ,#7070303 ,#1C1C0E0E,#3838     ,#0        ,#0        ,#1C1C0E0E,
#70703838,#C0C0E0E0,#7070E0E0,#1C1C3838,#E0E      ,#0        ,#0        ,
#38387070,#E0F1C1C ,#3030707 ,#1010101 ,#1010101 ,#101      ,#0        ,
#0        ,#E0E0707 ,#38381C1C,#E0E07070,#C0C0C0C0,#C0C0C0C0,#C0C0     ,
#0        ,#0        ,#3F3F     ,#0        ,#1010000 ,#7070303 ,#1C1C0E0E,
#3F3F     ,#0        ,#0        ,#1C1CFEFE,#70703838,#C0C0E0E0,#8080     ,
#0        ,#FEFE     ,#0        ,#0        ,#7070707 ,#7070707 ,#7070707 ,
#7070707 ,#7070707 ,#707      ,#0        ,#0        ,#F0F0     ,#0        ,
#0        ,#0        ,#0        ,#F0F0     ,#0        ,#0        ,#38387070,
#E0E1C1C ,#3030707 ,#101      ,#0        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#80800000,#E0E0C0C0,#38387070,#1C1C     ,#0        ,
#0        ,#707      ,#0        ,#0        ,#0        ,#0        ,#707      ,
#0        ,#0        ,#7070F0F0,#70707070,#70707070,#70707070,#70707070,
#F0F0     ,#0        ,#0        ,#3030101 ,#E0E     ,#1C1C     ,#0        ,
#0        ,#0        ,#0        ,#0        ,#E0E0C0C0,#38387070,#1C1C     ,
#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#0        ,#0        ,#0        ,#7F7F     ,#0        ,
#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,#FEFE     ,
#3010000 ,#1030303 ,#0        ,#0        ,#0        ,#0        ,#0        ,
#0        ,#80C0E060,#C0E0E0C0,#0        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#0        ,#0        ,#  C0F07  ,#1F0F0000,#3C38383C,
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#F1F     ,#0       ,#0       ,#0       ,#0       ,#1C3CF8F0,#FCFC1C1C,
#1C1C1C1C,#FCFC    ,#0       ,#0       ,#38383838,#38383838,#38383F3F,
#38383838,#38383838,#3F3F    ,#0       ,#0       ,#0       ,#0       ,
#1C3CF8F0,#1C1C1C1C,#3C1C1C1C,#F0F8    ,#0       ,#0       ,#0       ,
#0       ,#383C1F0F,#38383838,#3C383838,#F1F     ,#0       ,#0       ,
#0       ,#0       ,#1C3CF8F0,#0       ,#3C1C0000,#F0F8    ,#0       ,
#0       ,#0       ,#0       ,#383C1F0F,#38383838,#3C383838,#F1F     ,
#0       ,#0       ,#1C1C1C1C,#1C1C1C1C,#1C1CFCFC,#1C1C1C1C,#1C1C1C1C,
#FCFC    ,#0       ,#0       ,#0       ,#0       ,#383C1F0F,#3F3F3838,
#3C383838,#F1F     ,#0       ,#0       ,#0       ,#0       ,#1C3CF8F0,
#FCFC1C1C,#0       ,#F8F8    ,#0       ,#0       ,#E0F0703 ,#E0E0E0E ,
#E0E3F3F ,#E0E0E0E ,#E0E0E0E ,#E0E     ,#0       ,#0       ,#3838F0E0,
#0       ,#E0E0    ,#0       ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#383C1F0F,#38383838,#3C383838,#F1F     ,#0       ,
#1F1F    ,#0       ,#0       ,#1C1CFCFC,#1C1C1C1C,#1C1C1C1C,#1C1CFCFC,
#3C1C1C1C,#F0F8    ,#38383838,#38383838,#38383F3F,#38383838,#38383838,
#3838    ,#0       ,#0       ,#0       ,#0       ,#1C3CF8F0,#1C1C1C1C,
#1C1C1C1C,#1C1C    ,#0       ,#0       ,#1010101 ,#0       ,#1010F0F ,
#1010101 ,#1010101 ,#1F1F    ,#0       ,#0       ,#C0C0C0C0,#0       ,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#FCFC    ,#0       ,#0       ,#0       ,
#0       ,#101     ,#0       ,#0       ,#0       ,#1E1C0000,#70F     ,
#38383838,#0       ,#3838F8F8,#38383838,#38383838,#38383838,#78383838,
#E0F0    ,#38383838,#38383838,#38383838,#3F3F3B39,#3838393B,#3838    ,
#0       ,#0       ,#0       ,#0       ,#E070381C,#80C0    ,#70E0C080,
#1C38    ,#0       ,#0       ,#1010F0F ,#1010101 ,#1010101 ,#1010101 ,
#1010101 ,#1F1F    ,#0       ,#0       ,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#FCFC    ,#0       ,#0       ,#0       ,#0       ,
#71737F7F,#71717171,#71717171,#7171    ,#0       ,#0       ,#0       ,
#0       ,#C7CFFE7C,#C7C7C7C7,#C7C7C7C7,#C7C7    ,#0       ,#0       ,
#0       ,#0       ,#38383F3F,#38383838,#38383838,#3838    ,#0       ,
#0       ,#0       ,#0       ,#1C3CF8F0,#1C1C1C1C,#1C1C1C1C,#1C1C    ,
#0       ,#0       ,#0       ,#0       ,#383C1F0F,#38383838,#38383838,
#F1F     ,#0       ,#0       ,#0       ,#0       ,#1C3CF8F0,#1C1C1C1C,
#3C1C1C1C,#F0F8    ,#0       ,#0       ,#0       ,#0       ,#38383F3F,
#38383838,#38383838,#38383F3F,#38383838,#3838    ,#0       ,#0       ,
#1C3CF8F0,#1C1C1C1C,#3C1C1C1C,#F0F8    ,#0       ,#0       ,#0       ,
#0       ,#383C1F0F,#38383838,#3C383838,#F1F     ,#0       ,#0       ,
#0       ,#0       ,#1C1CFCFC,#1C1C1C1C,#1C1C1C1C,#1C1CFCFC,#1C1C1C1C,
#1C1C    ,#0       ,#0       ,#1C1C1F1F,#1C1C1C1C,#1C1C1C1C,#1C1C    ,
#0       ,#0       ,#0       ,#0       ,#1C3CF8F0,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#383C1F0F,#1071E3C ,
#3C380000,#F1F     ,#0       ,#0       ,#0       ,#0       ,#1C3CF8F0,
#E0800000,#3C1C3C78,#F0F8    ,#0       ,#0       ,#7070000 ,#7070707 ,
#7073F3F ,#7070707 ,#7070707 ,#103     ,#0       ,#0       ,#0       ,
#0       ,#F0F0    ,#0       ,#9C1C0000,#F0F8    ,#0       ,#0       ,
#0       ,#0       ,#38383838,#38383838,#3C383838,#F1F     ,#0       ,
#0       ,#0       ,#0       ,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#FCFC    ,
#0       ,#0       ,#0       ,#0       ,#1C383838,#E0E1C1C ,#3030707 ,
#101     ,#0       ,#0       ,#0       ,#0       ,#1C0E0E0E,#38381C1C,
#E0E07070,#C0C0    ,#0       ,#0       ,#0       ,#0       ,#70707070,
#71717171,#3F3F7B7B,#C0C     ,#0       ,#0       ,#0       ,#0       ,
#87870707,#C7C7C7C7,#7E7EEFEF,#1818    ,#0       ,#0       ,#0       ,
#0       ,#1C1C3838,#7070E0E ,#1C1C0E0E,#3838    ,#0       ,#0       ,
#0       ,#0       ,#70703838,#C0C0E0E0,#7070E0E0,#3838    ,#0       ,
#0       ,#0       ,#0       ,#38383838,#E0E1C1C ,#3030707 ,#101     ,
#3030101 ,#707     ,#0       ,#0       ,#E0E0E0E ,#1C1C1C1C,#B8B83838,
#E0E0F0F0,#8080C0C0,#0       ,#0       ,#0       ,#3F3F    ,#3010000 ,
#381C0E07,#3F3F    ,#0       ,#0       ,#0       ,#0       ,#381CFCFC,
#80C0E070,#0       ,#FCFC    ,#0       ,#0       ,#1010000 ,#1010101 ,
#30F0301 ,#1010101 ,#1010101 ,#0       ,#0       ,#0       ,#C0E0F878,
#C0C0C0C0,#800080C0,#C0C0C0C0,#E0C0C0C0,#78F8    ,#0       ,#0       ,
#1010101 ,#1010101 ,#101     ,#1010101 ,#1010101 ,#101     ,#0       ,
#0       ,#C0C0C0C0,#C0C0C0C0,#C0C0    ,#C0C0C0C0,#C0C0C0C0,#C0C0    ,
#0       ,#0       ,#1030F0F ,#1010101 ,#1       ,#1010101 ,#3010101 ,
#F0F     ,#0       ,#0       ,#C0C08000,#C0C0C0C0,#E078E0C0,#C0C0C0C0,
#C0C0C0C0,#80      ,#0       ,#0       ,#1F0F0000,#383839  ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#8E0E0000,#78FCCE  ,
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#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#3030101 ,
#E0E0707 ,#38381C1C,#7F7F    ,#0       ,#0       ,#0       ,#0       ,
#80800000,#E0E0C0C0,#38387070,#FCFC    ,#0       ,#0       ,#0       ,
#0       ,#383C1F0F,#38383838,#38383838,#38383838,#3C383838,#1010F1F ,
#707     ,#707     ,#1C3CF8F0,#0       ,#0       ,#0       ,#3C1C0000,
#C0C0F0F8,#E0E0C080,#80C0    ,#1C000000,#1C1C    ,#38383838,#38383838,
#3C383838,#F1F     ,#0       ,#0       ,#38000000,#3838    ,#1C1C1C1C,
#1C1C1C1C,#1C1C1C1C,#FCFC    ,#0       ,#0       ,#1000000 ,#703     ,
#383C1F0F,#3F3F3838,#3C383838,#F1F     ,#0       ,#0       ,#C0E07038,
#80      ,#1C3CF8F0,#FCFC1C1C,#0       ,#F8F8    ,#0       ,#0       ,
#7030100 ,#1C0E    ,#1F1F    ,#1F0F0000,#3C38383C,#F1F     ,#0       ,
#0       ,#70E0C080,#1C38    ,#1C3CF8F0,#FCFC1C1C,#1C1C1C1C,#FCFC    ,
#0       ,#0       ,#1C000000,#1C1C    ,#1F1F    ,#1F0F0000,#3C38383C,
#F1F     ,#0       ,#0       ,#38000000,#3838    ,#1C3CF8F0,#FCFC1C1C,
#1C1C1C1C,#FCFC    ,#0       ,#0       ,#3070E1C ,#1       ,#1F1F    ,
#1F0F0000,#3C38383C,#F1F     ,#0       ,#0       ,#80000000,#E0C0    ,
#1C3CF8F0,#FCFC1C1C,#1C1C1C1C,#FCFC    ,#0       ,#0       ,#6060703 ,
#307     ,#1F1F    ,#1F0F0000,#3C38383C,#F1F     ,#0       ,#0       ,
#6060E0C0,#C0E0    ,#1C3CF8F0,#FCFC1C1C,#1C1C1C1C,#FCFC    ,#0       ,
#0       ,#0       ,#0       ,#383C1F0F,#38383838,#3C383838,#1010F1F ,
#1010000 ,#0       ,#0       ,#0       ,#1C3CF8F0,#0       ,#3C1C0000,
#E0C0F0F8,#C0E07070,#0       ,#7030100 ,#1C0E    ,#383C1F0F,#3F3F3838,
#3C383838,#F1F     ,#0       ,#0       ,#70E0C080,#1C38    ,#1C3CF8F0,
#FCFC1C1C,#0       ,#F8F8    ,#0       ,#0       ,#1C000000,#1C1C    ,
#383C1F0F,#3F3F3838,#3C383838,#F1F     ,#0       ,#0       ,#38000000,
#3838    ,#1C3CF8F0,#FCFC1C1C,#0       ,#F8F8    ,#0       ,#0       ,
#103070E ,#0       ,#383C1F0F,#3F3F3838,#3C383838,#F1F     ,#0       ,
#0       ,#C0800000,#70E0    ,#1C3CF8F0,#FCFC1C1C,#0       ,#F8F8    ,
#0       ,#0       ,#1C000000,#1C1C    ,#1010F0F ,#1010101 ,#1010101 ,
#1F1F    ,#0       ,#0       ,#38000000,#3838    ,#C0CCC0C0,#C0C0C0C0,
#C0C0C0C0,#FCFC    ,#0       ,#0       ,#7030100 ,#1C0E    ,#1010F0F ,
#1010101 ,#1010101 ,#1F1F    ,#0       ,#0       ,#70E0C080,#1C38    ,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#FCFC    ,#0       ,#0       ,#103070E ,
#0       ,#1010F0F ,#1010101 ,#1010101 ,#1F1F    ,#0       ,#0       ,
#C0800000,#70E0    ,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#FCFC    ,#0       ,
#0       ,#1C1C1C00,#7030000 ,#38381C0E,#38383F3F,#38383838,#3838    ,
#0       ,#0       ,#38383800,#E0C00000,#1C1C3870,#1C1CFCFC,#1C1C1C1C,
#1C1C    ,#0       ,#3000000 ,#70E0E07 ,#7030003 ,#38381C0E,#38383F3F,
#38383838,#3838    ,#0       ,#E0000000,#F03838F0,#E0C000E0,#1C1C3870,
#1C1CFCFC,#1C1C1C1C,#1C1C    ,#0       ,#0       ,#E070301 ,#3F3F001C,
#38383838,#38383F3F,#38383838,#3F3F    ,#0       ,#E0000000,#80C0    ,
#FCFC0000,#0       ,#E0E0    ,#0       ,#FCFC    ,#0       ,#0       ,
#0       ,#0       ,#3073E3C ,#3F1F0303,#73737373,#1C3E    ,#0       ,
#0       ,#0       ,#0       ,#9C9CF870,#FCFC9C9C,#CC8C8080,#78FC    ,
#0       ,#0       ,#7070301 ,#E0E0E0E ,#1C1C1C1C,#38383F3F,#70707070,
#7070    ,#0       ,#0       ,#E0E0FEFE,#E0E0E0E0,#FCFCE0E0,#E0E0E0E0,
#E0E0E0E0,#FEFE    ,#0       ,#0       ,#7030100 ,#1C0E    ,#383C1F0F,
#38383838,#3C383838,#F1F     ,#0       ,#0       ,#70E0C080,#1C38    ,
#1C3CF8F0,#1C1C1C1C,#3C1C1C1C,#F0F8    ,#0       ,#0       ,#1C000000,
#1C1C    ,#383C1F0F,#38383838,#3C383838,#F1F     ,#0       ,#0       ,
#38000000,#3838    ,#1C3CF8F0,#1C1C1C1C,#3C1C1C1C,#F0F8    ,#0       ,
#0       ,#103070E ,#0       ,#383C1F0F,#38383838,#3C383838,#F1F     ,
#0       ,#0       ,#C0800000,#70E0    ,#1C3CF8F0,#1C1C1C1C,#3C1C1C1C,
#F0F8    ,#0       ,#0       ,#7030100 ,#1C0E    ,#38383838,#38383838,
#3C383838,#F1F     ,#0       ,#0       ,#70E0C080,#1C38    ,#1C1C1C1C,
#1C1C1C1C,#1C1C1C1C,#FCFC    ,#0       ,#0       ,#103070E ,#0       ,
#38383838,#38383838,#3C383838,#F1F     ,#0       ,#0       ,#C0800000,
#70E0    ,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#FCFC    ,#0       ,#0       ,
#1C000000,#1C1C    ,#1C383838,#E0E1C1C ,#3030707 ,#101     ,#3030101 ,
#707     ,#1C000000,#1C1C    ,#E0E0E0E ,#1C1C1C1C,#B8B83838,#E0E0F0F0,
#8080C0C0,#0       ,#1C1C1C  ,#383C1F0F,#38383838,#38383838,#3C383838,
#F1F     ,#0       ,#0       ,#383838  ,#1C3CF8F0,#1C1C1C1C,#1C1C1C1C,
#3C1C1C1C,#F0F8    ,#0       ,#0       ,#1C1C1C  ,#38383838,#38383838,
#38383838,#3C383838,#F1F     ,#0       ,#0       ,#383838  ,#1C1C1C1C,
#1C1C1C1C,#1C1C1C1C,#3C1C1C1C,#F0F8    ,#0       ,#0       ,#1010000 ,
#3F1F0101,#71717179,#1F3F7971,#1010101 ,#0       ,#0       ,#0       ,
#CJC00000,#FEFCC0C0,#C0C0C0CE,#FCFECEC0,#C0C0C0C0,#0       ,#0       ,
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#0       ,#1010100 ,#1010101 ,#7070101 ,#1010101 ,#3F1F0303,#1F3F7373,
#0       ,#0       ,#CECEFEFC,#C0C0C0C0,#F0F0C0C0,#C0C0C0C0,#80808080,
#1EBFF3C0,#0       ,#0       ,#38387070,#E0E1C1C ,#1030707 ,#1011F1F ,
#1011F1F ,#101     ,#0       ,#0       ,#E0E0707 ,#38381C1C,#C0E07070,
#C0C0FCFC,#C0C0FCFC,#C0C0    ,#0       ,#0       ,#38383F3F,#38383838,
#3F3F3838,#3B383838,#3838383B,#3838    ,#0       ,#0       ,#1C3CF8F0,
#1C1C1C1C,#F0F83C1C,#F8E0E000,#E0E0E0F8,#7CFC    ,#0       ,#0       ,
#0       ,#1010000 ,#F0F0101 ,#3030303 ,#7070303 ,#67670707,#3E7F    ,
#0       ,#E6E6FE7C,#C0C0E0E0,#F8F8C0C0,#80808080,#8080    ,#0       ,
#0       ,#0       ,#3010000 ,#E07     ,#1F1F    ,#1F0F0000,#3C38383C,
#F1F     ,#0       ,#0       ,#80C0E070,#0       ,#1C3CF8F0,#FCFC1C1C,
#1C1C1C1C,#FCFC    ,#0       ,#0       ,#3010000 ,#E07     ,#1010F0F ,
#1010101 ,#1010101 ,#1F1F    ,#0       ,#0       ,#80C0E070,#0       ,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#FCFC    ,#0       ,#0       ,#3010000 ,
#E07     ,#383C1F0F,#38383838,#3C383838,#F1F     ,#0       ,#0       ,
#80C0E070,#0       ,#1C3CF8F0,#1C1C1C1C,#3C1C1C1C,#F0F8    ,#0       ,
#0       ,#3010000 ,#E07     ,#38383838,#38383838,#3C383838,#F1F     ,
#0       ,#0       ,#80C0E070,#0       ,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,
#FCFC    ,#0       ,#0       ,#38391F0E,#0       ,#38383F3F,#38383838,
#38383838,#3838    ,#0       ,#0       ,#E0F03838,#0       ,#1C3CF8F0,
#1C1C1C1C,#1C1C1C1C,#1C1C    ,#0       ,#0       ,#38391F0E,#3C380000,
#3F3F3E3E,#39393B3B,#38383838,#3838    ,#0       ,#0       ,#E0F03838,
#1C1C0000,#1C1C1C1C,#DCDC9C9C,#7C7CFCFC,#1C3C    ,#0       ,#0       ,
#0       ,#0       ,#1F1F    ,#1F0F0000,#3C38383C,#F1F     ,#3F3F    ,
#0       ,#0       ,#0       ,#1C3CF8F0,#FCFC1C1C,#1C1C1C1C,#FCFC    ,
#FCFC    ,#0       ,#0       ,#0       ,#383C1F0F,#38383838,#3C383838,
#F1F     ,#3F3F    ,#0       ,#0       ,#0       ,#1C3CF8F0,#1C1C1C1C,
#3C1C1C1C,#F0F8    ,#FCFC    ,#0       ,#3070703 ,#3030000 ,#7070303 ,
#1C1C0E0E,#3C383838,#F1F     ,#0       ,#0       ,#80C0C080,#80800000,
#8080    ,#0       ,#3C1C0000,#F0F8    ,#0       ,#0       ,#0       ,
#0       ,#38383F3F,#3838    ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#FCFC    ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#3F3F    ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#1C1CFCFC,#1C1C    ,#0       ,
#0       ,#0       ,#0       ,#C3C1C0C ,#C0C0C0C ,#1013E3E ,#7070303 ,
#1C1C0E0E,#3838    ,#0       ,#0       ,#1C1C0E0E,#70703838,#C0C0E0E0,
#606BEBC ,#3030180C,#3E3E    ,#0       ,#0       ,#C3C1C0C ,#C0C0C0C ,
#1013E3E ,#7070303 ,#1C1C0E0E,#3838    ,#0       ,#0       ,#1C1C0E0E,
#70703838,#C0C0E0E0,#36369E8E,#FFFF6666,#606     ,#0       ,#0       ,
#70F0F07 ,#7070000 ,#F070707 ,#F0F0F0F ,#F0F0F0F ,#70F     ,#0       ,
#0       ,#808000  ,#0       ,#80000000,#80808080,#80808080,#80      ,
#0       ,#0       ,#0       ,#7070303 ,#1C1C0E0E,#1C1C3939,#7070E0E ,
#303     ,#0       ,#0       ,#0       ,#38389C9C,#E0E07070,#E0E0C0C0,
#38387070,#9C9C    ,#0       ,#0       ,#0       ,#1C1C3939,#7070E0E ,
#7070303 ,#1C1C0E0E,#3939    ,#0       ,#0       ,#0       ,#E0E0C0C0,
#38387070,#38389C9C,#E0E07070,#C0C0    ,#0       ,#22880000,#22882288,
#22882288,#22882288,#22882288,#22882288,#22882288,#22882288,#22882288,
#22882288,#22882288,#22882288,#22882288,#22882288,#22882288,#22882288,
#AA552288,#AA55AA55,#AA55AA55,#AA55AA55,#AA55AA55,#AA55AA55,#AA55AA55,
#AA55AA55,#AA55AA55,#AA55AA55,#AA55AA55,#AA55AA55,#AA55AA55,#AA55AA55,
#AA55AA55,#AA55AA55,#DD77AA55,#DD77DD77,#DD77DD77,#DD77DD77,#DD77DD77,
#DD77DD77,#DD77DD77,#DD77DD77,#DD77DD77,#DD77DD77,#DD77DD77,#DD77DD77,
#DD77DD77,#DD77DD77,#DD77DD77,#DD77DD77,#101DD77 ,#1010101 ,#1010101 ,
#1010101 ,#1010101 ,#1010101 ,#1010101 ,#1010101 ,#C0C00101,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#101C0C0 ,
#1010101 ,#1010101 ,#1010101 ,#101FFFF ,#1010101 ,#1010101 ,#1010101 ,
#C0C00101,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#101C0C0 ,#1010101 ,#1010101 ,#FFFF0101,#FFFF0101,#1010101 ,
#1010101 ,#1010101 ,#C0C00101,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#707C0C0 ,#7070707 ,#7070707 ,#7070707 ,
#707FFFF ,#7070707 ,#7070707 ,#7070707 ,#38380707,#38383838,#38383838,
#38383838,#38383838,#38383838,#38383838,#38383838,#3838    ,#0       ,
#0       ,#0       ,#707FFFF ,#7070707 ,#7070707 ,#7070707 ,#707     ,
#0       ,#0       ,#0       ,#3838F8F8,#38383838,#38383838,#38383838,
#3838    ,#0       ,#0       ,#FFFF0000,#FFFF0101,#1010101 ,#1010101 ,
#1010101 ,#101     ,#0       ,#0       ,#C0C00000,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#707C0C0 ,#7070707 ,#7070707 ,#FFFF0707,#FFFF0000,
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#7070707 ,#7070707 ,#7070707 ,#38380707,#38383838,#38383838,#38383838,
#38383838,#38383838,#38383838,#38383838,#7073838 ,#7070707 ,#7070707 ,
#7070707 ,#7070707 ,#7070707 ,#7070707 ,#7070707 ,#38380707,#38383838,
#38383838,#38383838,#38383838,#38383838,#38383838,#38383838,#3838    ,
#0       ,#0       ,#FFFF0000,#FFFF0000,#7070707 ,#7070707 ,#7070707 ,
#707     ,#0       ,#0       ,#F8F80000,#38383838,#38383838,#38383838,
#38383838,#7073838 ,#7070707 ,#7070707 ,#FFFF0707,#FFFF0000,#0       ,
#0       ,#0       ,#38380000,#38383838,#38383838,#38383838,#F8F83838,
#0       ,#0       ,#0       ,#7070000 ,#7070707 ,#7070707 ,#7070707 ,
#FFFF    ,#0       ,#0       ,#0       ,#38380000,#38383838,#38383838,
#38383838,#F8F8    ,#0       ,#0       ,#0       ,#1010000 ,#1010101 ,
#1010101 ,#FFFF0101,#FFFF0101,#0       ,#0       ,#0       ,#C0C00000,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#101FFFF ,#1010101 ,#1010101 ,
#1010101 ,#101     ,#0       ,#0       ,#0       ,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#101C0C0 ,#1010101 ,#1010101 ,#1010101 ,#101     ,
#0       ,#0       ,#0       ,#C0C00000,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,
#FFFF    ,#0       ,#0       ,#0       ,#1010000 ,#1010101 ,#1010101 ,
#1010101 ,#FFFF    ,#0       ,#0       ,#0       ,#C0C00000,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#FFFF    ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#101FFFF ,#1010101 ,#1010101 ,#1010101 ,
#101     ,#0       ,#0       ,#0       ,#C0C0FFFF,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#101C0C0 ,#1010101 ,#1010101 ,#1010101 ,#1010101 ,#1010101 ,
#1010101 ,#1010101 ,#C0C00101,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0FFFF,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0    ,#0       ,#0       ,#0       ,
#FFFF    ,#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,
#0       ,#FFFF    ,#0       ,#0       ,#0       ,#1010000 ,#1010101 ,
#1010101 ,#1010101 ,#101FFFF ,#1010101 ,#1010101 ,#1010101 ,#C0C00101,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0FFFF,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,
#101C0C0 ,#1010101 ,#1010101 ,#1010101 ,#1010101 ,#1010101 ,#1010101 ,
#1010101 ,#C0C00101,#C0C0C0C0,#C0C0C0C0,#FFFFC0C0,#FFFFC0C0,#C0C0C0C0,
#C0C0C0C0,#C0C0C0C0,#707C0C0 ,#7070707 ,#7070707 ,#7070707 ,#7070707 ,
#7070707 ,#7070707 ,#7070707 ,#38380707,#38383838,#38383838,#38383838,
#38383F3F,#38383838,#38383838,#38383838,#7073838 ,#7070707 ,#7070707 ,
#7070707 ,#7070707 ,#0       ,#0       ,#0       ,#38380000,#38383838,
#38383838,#3F3F3838,#FFFF0000,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#7070000 ,#7070707 ,#7070707 ,#7070707 ,#7070707 ,
#707     ,#0       ,#0       ,#FFFF0000,#3F3F0000,#38383838,#38383838,
#38383838,#7073838 ,#7070707 ,#7070707 ,#FFFF0707,#FFFF0000,#0       ,
#0       ,#0       ,#38380000,#38383838,#38383838,#3F3F3838,#FFFF0000,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#FFFF0000,
#FFFF0000,#7070707 ,#7070707 ,#7070707 ,#707     ,#0       ,#0       ,
#FFFF0000,#3F3F0000,#38383838,#38383838,#38383838,#7073838 ,#7070707 ,
#7070707 ,#7070707 ,#7070707 ,#7070707 ,#7070707 ,#7070707 ,#38380707,
#38383838,#38383838,#3F3F3838,#3F3F0000,#38383838,#38383838,#38383838,
#3838    ,#0       ,#0       ,#FFFF0000,#FFFF0000,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#FFFF0000,#FFFF0000,#0       ,
#0       ,#0       ,#7070000 ,#7070707 ,#7070707 ,#FFFF0707,#FFFF0000,
#7070707 ,#7070707 ,#7070707 ,#38380707,#38383838,#38383838,#3F3F3838,
#3F3F0000,#38383838,#38383838,#38383838,#1013838 ,#1010101 ,#1010101 ,
#FFFF0101,#FFFF0000,#0       ,#0       ,#0       ,#C0C00000,#C0C0C0C0,
#C0C0C0C0,#FFFFC0C0,#FFFF0000,#0       ,#0       ,#0       ,#7070000 ,
#7070707 ,#7070707 ,#7070707 ,#FFFF    ,#0       ,#0       ,#0       ,
#38380000,#38383838,#38383838,#38383838,#FFFF    ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#FFFF0000,#FFFF0000,#1010101 ,
#1010101 ,#1010101 ,#101     ,#0       ,#0       ,#FFFF0000,#FFFF0000,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0    ,#0       ,#0       ,#0       ,
#707FFFF ,#7070707 ,#7070707 ,#70707.7 ,#707     ,#0       ,#0       ,
#0       ,#3838FFFF,#38383838,#38383838,#38383838,#7073838 ,#7070707 ,
#7070707 ,#7070707 ,#707     ,#0       ,#0       ,#0       ,#38380000,
#38383838,#38383838,#38383838,#FFFF    ,#0       ,#0       ,#0       ,
#1010000 ,#1010101 ,#1010101 ,#1010101 ,#1010101 ,#0       ,#0       ,
#0       ,#C0C00000,#C0C0C0C0,#C0C0C0C0,#FFFFC0C0,#FFFFC0C0,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#1010000 ,#1010101 ,
#1010101 ,#1010101 ,#1010101 ,#101     ,#0       ,#0       ,#FFFF0000,
#FFFFC0C0,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#C0C0    ,#0       ,#0       ,
#0       ,#7070707 ,#7070707 ,#7070707 ,#7070707 ,#707     ,#0       ,
```

```
#0       ,#0       ,#3838FFFF,#38383838,#38383838,#38383838,#7073838 ,
#7070707 ,#7070707 ,#7070707 ,#707FFFF ,#7070707 ,#7070707 ,#7070707 ,
#38380707,#38383838,#38383838,#38383838,#3838FFFF,#38383838,#38383838,
#38383838,#1013838 ,#1010101 ,#1010101 ,#FFFF0101,#FFFF0101,#1010101 ,
#1010101 ,#10.0101 ,#C0C00101,#C0C0C0C0,#C0C0C0C0,#FFFFC0C0,#FFFFC0C0,
#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,#101C0C0 ,#1010101 ,#1010101 ,#1010101 ,
#FFFF    ,#0       ,#0       ,#0       ,#C0C00000,#C0C0C0C0,#C0C0C0C0,
#C0C0C0C0,#C0C0    ,#0       ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#1010101 ,#1010101 ,#1010101 ,#1010101 ,#101     ,
#0       ,#0       ,#0       ,#C0C0FFFF,#C0C0C0C0,#C0C0C0C0,#C0C0C0C0,
#FFFFC0C0,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,
#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,
#FFFFFFFF,#FFFFFFFF,#FFFF    ,#0       ,#0       ,#0       ,#FFFF0000,
#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFF    ,#0       ,#0       ,#0       ,
#FFFF0000,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,
#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFF    ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,
#FFFF0000,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,
#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFF    ,#0       ,
#0       ,#0       ,#FFFF0000,#FFFFFFFF,#FFFFFFFF,#FFFFFFFF,#FFFF    ,
#0       ,#0       ,#0       ,#0       ,#0       ,#0       ,#70783F1F,
#70707070,#78707070,#1F3F    ,#0       ,#0       ,#0       ,#0       ,
#78FCCE87,#38383838,#FC783838,#C7EE    ,#0       ,#0       ,#7070707 ,
#E0E0707 ,#E0E0E0E ,#1C1C1C1C,#3F3F1C1C,#38383838,#3838    ,#0       ,
#1C1CF8F0,#70381C1C,#383870E0,#1C1C1C1C,#E0F0783C,#0       ,#0       ,
#0       ,#38383F3F,#38383838,#38383838,#38383838,#38383838,#3838    ,
#0       ,#0       ,#C0CFCFC ,#0       ,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#0       ,#0       ,#6E6E3F1F,#1C1C0E0E,
#38381C1C,#3838    ,#0       ,#0       ,#0       ,#0       ,#3838FEFE,
#70703838,#E0E07070,#E0E0    ,#0       ,#0       ,#1C1C3F3F,#7070E0E ,
#1010303 ,#7070303 ,#1C1C0E0E,#3F3F    ,#0       ,#0       ,#C0CFCFC ,
#0       ,#C0C08080,#8080    ,#C0C0000 ,#FCFC    ,#0       ,#0       ,
#0       ,#0       ,#70783F1F,#70707070,#78707070,#1F3F    ,#0       ,
#0       ,#0       ,#0       ,#3870FFFF,#38383838,#78383838,#E0F0    ,
#0       ,#0       ,#0       ,#0       ,#E0E0E0E ,#E0E0E0E ,#F0E0E0E ,
#E0E0E0F ,#6E0E0E0E,#3C7E    ,#0       ,#0       ,#7070707 ,#7070707 ,
#F070707 ,#FCFE    ,#0       ,#0       ,#0       ,#0       ,#31311F0F,
#3030101 ,#7070303 ,#707     ,#0       ,#0       ,#0       ,#0       ,
#C0C0FCFC,#8080C0C0,#8080    ,#0       ,#0       ,#0       ,#1010707 ,
#F0F0101 ,#1C1C1C1C,#F0F1C1C ,#1010101 ,#707     ,#0       ,#0       ,
#C0C0F0F0,#F8F8C0C0,#1C1C1C1C,#F8F81C1C,#C0C0C0C0,#F0F0    ,#0       ,
#0       ,#383C1F0F,#38383838,#3F3F3838,#38383838,#3C383838,#F1F     ,
#0       ,#0       ,#1C3CF8F0,#1C1C1C1C,#FCFC1C1C,#1C1C1C1C,#3C1C1C1C,
#F0F8    ,#0       ,#0       ,#383C1F0F,#38383838,#38383838,#38383838,
#E0E1C1C ,#3E3E    ,#0       ,#0       ,#1C3CF8F0,#1C1C1C1C,#1C1C1C1C,
#1C1C1C1C,#70703838,#7C7C    ,#0       ,#0       ,#3030100 ,#101     ,
#383C1F0F,#38383838,#3C383838,#F1F     ,#0       ,#0       ,#8C8CF8F0,
#E0E0C0C0,#1C3CF8F0,#1C1C1C1C,#3C1C1C1C,#F0F8    ,#0       ,#0       ,
#0       ,#0       ,#71733F1E,#1E3F7371,#0       ,#0       ,#0       ,
#0       ,#0       ,#0       ,#C7E77E3C,#3C7EE7C7,#0       ,#0       ,
#0       ,#0       ,#0       ,#F070000 ,#1C1C1C1C,#1D1D1D1D,#303070F ,
#303     ,#0       ,#0       ,#60600000,#F8F06060,#DCDCDCDC,#9C9C9C9C,
#F0F8    ,#0       ,#0       ,#0       ,#E0F0703 ,#38381C1C,#3F3F3838,
#38383838,#F0E1C1C ,#307     ,#0       ,#0       ,#FCFC    ,#0       ,
#FCFC0000,#0       ,#0       ,#FCFC    ,#0       ,#0       ,#383C1F0F,
#38383838,#38383838,#38383838,#38383838,#3838    ,#0       ,#0       ,
#1C3CF8F0,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#1C1C1C1C,#1C1C    ,#0       ,
#0       ,#0       ,#0       ,#3F3F    ,#3F3F    ,#3F3F    ,#0       ,
#0       ,#0       ,#0       ,#0       ,#FCFC    ,#FCFC    ,#FCFC    ,
#0       ,#0       ,#0       ,#0       ,#3030000 ,#3F3F0303,#3030303 ,
#3F3F0000,#0       ,#0       ,#0       ,#0       ,#80800000,#F8F88080,
#80808080,#F8F80000,#0       ,#0       ,#0       ,#0       ,#3030707 ,
#101     ,#0       ,#3030101 ,#707     ,#1F1F    ,#0       ,#0       ,
#80800000,#E0E0C0C0,#E0E07070,#8080C0C0,#0       ,#F0F0    ,#0       ,
#0       ,#1010000 ,#7070303 ,#7070E0E ,#1010303 ,#0       ,#F0F     ,
#0       ,#0       ,#C0C0E0E0,#8080    ,#0       ,#C0C08080,#E0E0    ,
```

```
#F0F0     ,#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,
#1010000  ,#1010101  ,#101      ,#0        ,#E0E6FE7C,#E0E0E0E0,#E0E0E0E0,
#E0E0E0E0,#C0C0E0E0,#C0C0C0C0,#101C0C0  ,#1010101  ,#3030101  ,#3030303  ,
#3030303  ,#3030303  ,#1F3F3303,#0        ,#C0C00000,#C0C0C0C0,#8080C0C0,
#80808080,#80808080,#80808080,#808080   ,#0        ,#0        ,#0        ,
#3070703  ,#3F3F0000,#7030000  ,#307      ,#0        ,#0        ,#0        ,
#0        ,#80C0C080,#F8F80000,#C0800000,#80C0     ,#0        ,#0        ,
#0        ,#0        ,#1F0F0000,#3839     ,#38391F0F,#0        ,#0        ,
#0        ,#0        ,#0        ,#9C1C0000,#F0F8     ,#F0F89C1C,#0        ,
#0        ,#0        ,#0        ,#E0E0703  ,#3070E0E  ,#0        ,#0        ,
#0        ,#0        ,#0        ,#0        ,#3838F0E0,#E0F03838,#0        ,
#0        ,#0        ,#0        ,#0        ,#0        ,#7070300  ,#30707    ,
#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,#E0E0C000,
#C0E0E0   ,#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,
#0        ,#3000000  ,#7070707  ,#3        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#C0000000,#E0E0E0E0,#C0       ,#0        ,#0        ,
#0        ,#0        ,#0        ,#0        ,#0        ,#1C1C7878,#7070E0E  ,
#1010303  ,#0        ,#7F7F0000,#70707070,#70707070,#70707070,#70707070,
#70707070,#F0F0F0F0,#7070F0F0,#0        ,#6060707  ,#6060606  ,#606      ,
#0        ,#0        ,#0        ,#0        ,#0        ,#6060C080,#60606060,
#6060     ,#0        ,#0        ,#0        ,#0        ,#0        ,#707      ,
#6060301  ,#707      ,#0        ,#0        ,#0        ,#0        ,#0        ,
#6060E0C0,#80C0     ,#E0E0     ,#0        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#7070000  ,#7070707  ,#7070707  ,#0        ,#0        ,
#0        ,#0        ,#0        ,#E0E00000,#E0E0E0E0,#E0E0E0E0,#0        ,
#0        ,#0        ,#0        ,#383C1F0F,#77777370,#77777777,#77777777,
#3C387073,#F1F      ,#0        ,#0        ,#E1EFCF8  ,#37F7E707,#7070737  ,
#F7373707,#1E0E07E7,#F8FC     ,#0        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,
#0        ,#0        ,#0        ,#0        ,#0        ,#0        ,#1A1A0000]:
```

4.3. Makefiles

4.3.1. Seeker

```
LIBRARIAN=ilibr
OCCAM=occam
LINK=ilink
CONFIG=iconf
ADDBOOT=iboot
LIBOPT=
OCCOPT=/a
LINKOPT=
CONFOPT=
BOOTOPT=

seeker.btl:     seeker.pgm controll.t8h guidance.t8h xbar.t2h gtsei.t2h \
          backgrou.t8h targetle.t8h target.t8h spcontro.t8h sp.t4h firstbuf.t8h \
          secondbu.t8h formatte.t8h imagedis.c8h trackdis.c8h b409stub.c2h \
          gtspi.t2h hostseek.c8h
        $(CONFIG) seeker /o seeker.btl $(CONFOPT)

HostSeek.c8h:  HostSeek.l8h HostSeek.t8h
        $(LINK) /f HostSeek.l8h /o HostSeek.c8h $(LINKOPT)

HostSeek.t8h:  HostSeek.occ s_header.inc c:\itools\libs\hostio.inc \
          c:\itools\libs\hostio.lib c:\itools\libs\hostio.liu \
          c:\itools\libs\convert.lib gif02.c8h loader.c8h runseekr.c8h
        $(OCCAM) HostSeek /t8 /h /o HostSeek.t8h $(OCCOPT)

gif02.c8h:      gif02.l8h gif02.t8h
        $(LINK) /f gif02.l8h /o gif02.c8h $(LINKOPT)

gif02.t8h:      gif02.occ c:\itools\libs\hostio.inc c:\itools\libs\hostio.lib \
          c:\itools\libs\hostio.liu c:\itools\libs\convert.lib
        $(OCCAM) gif02 /t8 /h /o gif02.t8h $(OCCOPT)

loader.c8h:     loader.l8h loader.t8h
        $(LINK) /f loader.l8h /o loader.c8h $(LINKOPT)

loader.t8h:     loader.occ s_header.inc c:\itools\libs\hostio.inc \
          c:\itools\libs\hostio.lib c:\itools\libs\hostio.liu \
          c:\itools\libs\convert.lib
        $(OCCAM) loader /t8 /h /o loader.t8h /a

runseekr.c8h:  runseekr.l8h runseekr.t8h
        $(LINK) /f runseekr.l8h /o runseekr.c8h $(LINKOPT)

runseekr.t8h:  runseekr.occ s_header.inc c:\itools\libs\hostio.inc \
          c:\itools\libs\hostio.lib c:\itools\libs\hostio.liu \
          c:\itools\libs\convert.lib
        $(OCCAM) runseekr /t8 /h /o runseekr.t8h $(OCCOPT)

controll.t8h:  controll.occ s_header.inc
        $(OCCAM) controll /t8 /h /o controll.t8h $(OCCOPT)

guidance.t8h:  guidance.occ s_header.inc
        $(OCCAM) guidance /t8 /h /o guidance.t8h $(OCCOPT)

xbar.t2h:       xbar.occ s_header.inc
        $(OCCAM) xbar /t2 /h /o xbar.t2h $(OCCOPT)

gtspi.t2h:      gtspi.occ s_header.inc
        $(OCCAM) gtspi /t2 /h /o gtspi.t2h $(OCCOPT)

gtsei.t2h:      gtsei.occ s_header.inc
        $(OCCAM) gtsei /t2 /h /o gtsei.t2h $(OCCOPT)
```

```
backgrou.t8h:  backgrou.occ s_header.inc
        $(OCCAM) backgrou /t8 /h /o backgrou.t8h $(OCCOPT)

targetle.t8h:  targetle.occ s_header.inc
        $(OCCAM) targetle /t8 /h /o targetle.t8h $(OCCOPT)

target.t8h:    target.occ s_header.inc
        $(OCCAM) target /t8 /h /o target.t8h $(OCCOPT)

spcontro.t8h:  spcontro.occ s_header.inc
        $(OCCAM) spcontro /t8 /h /o spcontro.t8h $(OCCOPT)

sp.t4h: sp.occ s_header.inc
        $(OCCAM) sp /t4 /h /o sp.t4h $(OCCOPT)

firstbuf.t8h:  firstbuf.occ
        $(OCCAM) firstbuf /t8 /h /o firstbuf.t8h $(OCCOPT)

secondbu.t8h:  secondbu.occ
        $(OCCAM) secondbu /t8 /h /o secondbu.t8h $(OCCOPT)

formatte.t8h:  formatte.occ
        $(OCCAM) formatte /t8 /h /o formatte.t8h $(OCCOPT)

imagedis.c8h:  imagedis.l8h imagedis.t8h
        $(LINK) /f imagedis.l8h /o imagedis.c8h $(LINKOPT)

imagedis.t8h:  imagedis.occ crtc.inc g_header.inc c:\itools\libs\convert.lib \
          graphics.lib s_header.inc
        $(OCCAM) imagedis /t8 /h /o imagedis.t8h $(OCCOPT)

graphics.lib:  graphics.lbb b409.t2h g_line.t8h g_system.t8h g_text.t8h
        $(LIBRARIAN) /f graphics.lbb  /o graphics.lib $(LIBOPT)

b409.t2h:      b409.occ crtc.inc
        $(OCCAM) b409 /t2 /h /o b409.t2h $(OCCOPT)

g_line.t8h:    g_line.occ g_header.inc
        $(OCCAM) g_line /t8 /h /o g_line.t8h $(OCCOPT)

g_system.t8h:  g_system.occ crtc.inc g_header.inc
        $(OCCAM) g_system /t8 /h /o g_system.t8h $(OCCOPT)

g_text.t8h:    g_text.occ g_header.inc
        $(OCCAM) g_text /t8 /h /o g_text.t8h $(OCCOPT)

trackdis.c8h:  trackdis.l8h trackdis.t8h
        $(LINK) /f trackdis.l8h /o trackdis.c8h $(LINKOPT)

trackdis.t8h:  trackdis.occ s_header.inc g_header.inc crtc.inc \
          c:\itools\libs\convert.lib graphics.lib sys6.inc
        $(OCCAM) trackdis /t8 /h /o trackdis.t8h $(OCCOPT)

b409stub.c2h:  b409stub.l2h b409stub.t2h
        $(LINK) /f b409stub.l2h /o b409stub.c2h $(LINKOPT)

b409stub.t2h:  b409stub.occ crtc.inc graphics.lib
        $(OCCAM) b409stub /t2 /h /o b409stub.t2h $(OCCOPT)
```

4.3.2. HostSeeker

```
LIBRARIAN=ilibr
OCCAM=occam
LINK=ilink
CONFIG=iconf
ADDBOOT=iboot
LIBOPT=
OCCOPT=
LINKOPT=
CONFOPT=
BOOTOPT=

hostseek.c8h:  hostseek.l8h hostseek.t8h
       $(LINK) /f hostseek.l8h /o hostseek.c8h $(LINKOPT)

hostseek.t8h:  hostseek.occ s_header.inc c:\itools\libs\hostio.inc \
         c:\itools\libs\hostio.lib c:\itools\libs\hostio.liu \
         c:\itools\libs\convert.lib
       $(OCCAM) hostseek /t8 /h /o hostseek.t8h $(OCCOPT)
```

4.3.3. Graphics

```
LIBRARIAN=ilibr
OCCAM=occam
LINK=ilink
CONFIG=iconf
ADDBOOT=iboot
LIBOPT=
OCCOPT=
LINKOPT=
CONFOPT=
BOOTOPT=

graphics.lib:  graphics.lbb b409.t2h g_line.t8h g_system.t8h g_text.t8h
       $(LIBRARIAN) /f graphics.lbb  /o graphics.lib $(LIBOPT)

b409.t2h:      b409.occ crtc.inc
       $(OCCAM) b409 /t2 /h /o b409.t2h $(OCCOPT)

g_line.t8h:    g_line.occ g_header.inc
       $(OCCAM) g_line /t8 /h /o g_line.t8h $(OCCOPT)

g_system.t8h:  g_system.occ crtc.inc g_header.inc
       $(OCCAM) g_system /t8 /h /o g_system.t8h $(OCCOPT)

g_text.t8h:    g_text.occ g_header.inc
       $(OCCAM) g_text /t8 /h /o g_text.t8h $(OCCOPT)
```

4.3.4. B409stub.l2h

```
--
-- Version 2.80, 28th April 1989
--
-- linker command file "c:\seeker\b409stub.l2h"
--
b409stub.t2h
graphics.lib
occam2h.lib
```

4.3.5. GIF02.l8h

```
--
-- Version 2.80, 28th April 1989
--
-- linker command file "gif02.l8h"
--
gif02.t8h
hostio.lib
convert.lib
occam8h.lib
```

4.3.6. HostSeeker.l8h

```
--
-- Version 2.80, 28th April 1989
--
-- linker command file "HostSeek.l8h"
--
HostSeek.t8h
=gif02.t8h
=loader.t8h
=runseekr.t8h
hostio.lib
convert.lib
gif02.c8h
loader.c8h
runseekr.c8h
occam8h.lib
```

4.3.7. ImageDisplay.l8h

```
--
-- Version 2.80, 28th April 1989
--
-- linker command file "imagedis.l8h"
--
imagedis.t8h
convert.lib
graphics.lib
occam8h.lib
```

4.3.8. Loader.l8h

```
--
-- Version 2.80, 28th April 1989
--
-- linker command file "loader.l8h"
--
loader.t8h
hostio.lib
convert.lib
occam8h.lib
```

4.3.9. RunSeekr.l8h

```
--
-- Version 2.80, 28th April 1989
--
-- linker command file "runseekr.l8h"
--
runseekr.t8h
hostio.lib
convert.lib
occam8h.lib
```

4.3.10. TrackDisplay.l8h

```
--
-- Version 2.80, 28th April 1989
--
-- linker command file "trackdis.l8h"
--
trackdis.t8h
convert.lib
graphics.lib
occam8h.lib
```

5. Appendix B: Program Listings (Scene generation for SP testing)

5.1. PC Source Code (Modula-2)

5.1.1. SPTest.mod

```
MODULE SPTest ;
IMPORT Graph, IO, Objects, FIO, Image, Scenario;
VAR
  c     : CHAR ;
  f, scene : FIO.File ;
  i,j : CARDINAL ;
  dummy : BOOLEAN ;
BEGIN

  (*f:= FIO.OpenRead ("objects.dat") ;*)
  scene := FIO.OpenRead ("scene.dat") ;
(*  Objects.LoadObjects(f) ;*)
  Image.Init () ;
  Scenario.ParseScenario (scene) ;
  c:=IO.RdKey () ;
END SPTest.
```

5.1.2. Image.def

```
DEFINITION MODULE Image;

VAR
  MaskMode :  (NOMASK, MASK, UNMASK) ;
  PixelMode : (OVERLAY, ADD) ;

PROCEDURE NewFrame () ;

PROCEDURE Plot (x, y, Color : CARDINAL) ;

PROCEDURE Polygon (n : CARDINAL; px, py: ARRAY OF CARDINAL;
                   FillColor : CARDINAL) ;
PROCEDURE Init () ;

END Image.
```

5.1.3. Image.mod

```
IMPLEMENTATION MODULE Image ;
IMPORT Graph ;
PROCEDURE Min (a,b :CARDINAL) : CARDINAL ;
BEGIN
  IF a > b THEN RETURN b
  ELSE RETURN a END ;
END Min;

PROCEDURE NewFrame () ;
BEGIN
  Graph.Rectangle (0, 0, 127, 127, 0, TRUE) ;
END NewFrame ;

PROCEDURE Plot (x, y, Color : CARDINAL) ;
VAR temp : CARDINAL ;
BEGIN
  temp :=Graph.Point (x, y) ;
  IF (MaskMode = MASK)   AND (temp = 0) THEN RETURN END ;
  IF (MaskMode = UNMASK) AND (temp # 0) THEN RETURN END ;
  CASE PixelMode OF
    | OVERLAY :
      Graph.Plot (x, y, Min(189, Color)) ;
    | ADD :
      Graph.Plot (x, y, Min(189, Color+ temp)) ;
  END ; (* case *)

END Plot;

PROCEDURE Polygon (n : CARDINAL; px, py: ARRAY OF CARDINAL;
                   FillColor : CARDINAL) ;
BEGIN
  Graph.Polygon (n, px, py, FillColor) ;

END Polygon;

PROCEDURE Init () ;

VAR dummy : BOOLEAN ;
    palette : ARRAY [0..255] OF LONGCARD ;
    longI, temp : LONGCARD ;
    i : CARDINAL ;
BEGIN
  MaskMode := NOMASK ;
  PixelMode := OVERLAY ;
  FOR i := 0 TO 63 DO
    longI := LONGCARD (i) ;
    temp := (longI) + (longI << 8) + (longI << 16) ;
```

```
    palette[i*3] := temp ;
    palette[i*3 + 1] := palette[i*3] + 1 ;
    palette[i*3 + 2] := palette[i*3+1] + 256 ;
  END ; (* for *)
  dummy := Graph.SetVideoMode (Graph._MRES256COLOR) ;
  IF Graph.RemapAllPalette(palette) <> 0 THEN END ;
  Graph.Line (0, 0, 0, 128, 200) ;
  Graph.Line (128, 128, 128, 0, 200) ;
  Graph.Line (0, 128, 128, 128, 200) ;
  Graph.Line (128, 0, 0, 0, 200) ;
  Graph.SetClipRgn (1, 1, 127, 127) ;
END Init;

BEGIN
END Image.
```

5.1.4. Objects.def

```
DEFINITION MODULE Objects ;

IMPORT FIO ;

PROCEDURE LoadObjects (f: FIO.File) ;

PROCEDURE DisplayObject (id, x, y, color: CARDINAL;
                         scale : REAL) : BOOLEAN;

END Objects.
```

5.1.5. Objects.mod

```
IMPLEMENTATION MODULE Objects ;

IMPORT Str, FIO, IO,  Image ;

CONST
  maxPoints = 32 ;
  maxDimension = 8 ;
  maxObjects = 120 ;
TYPE
  ObjectType = (Polygon, Bitmap) ;
  Object = RECORD
             id : CARDINAL ;
             CASE type : ObjectType OF
               | Polygon :
                           numPoints : CARDINAL ;
                           x : ARRAY [1..maxPoints] OF REAL;
                           y : ARRAY [1..maxPoints] OF REAL;
               | Bitmap  : xExtent, yExtent : CARDINAL ;
                           intensity : ARRAY [1..maxDimension] OF
                                       ARRAY [1..maxDimension] OF REAL ;
             END ;
           END ;
  ObjectArray = ARRAY [0..maxObjects] OF Object ;

VAR
  object : ObjectArray ;

PROCEDURE LoadObjects (f: FIO.File) ;
VAR
  id, i, j : CARDINAL ;
  temp : ARRAY [0..32] OF CHAR ;
BEGIN
(*  REPEAT*)
    id := FIO.RdCard (f) ;
(*IO.WrCard (id, 6) ;*)
    FIO.RdStr (f, temp) ;
    Str.Caps (temp) ;
    WITH object[id] DO

      IF     Str.Match (temp, "*POLYGON*") THEN
        type := Polygon ;
(*IO.WrStr (" Polygon") ;*)
(*IO.WrLn() ;*)
        numPoints := FIO.RdCard (f) ;
        FOR i := 1 TO numPoints DO
          x[i] := FIO.RdReal (f) ;
          y[i] := FIO.RdReal (f) ;
        END ;

      ELSIF Str.Match (temp, "*BITMAP*") THEN
        type := Bitmap ;
(*IO.WrStr (" Bitmap") ;*)
```

```
(*IO.WrLn() ;*)
        xExtent := FIO.RdCard (f) ;
        yExtent := FIO.RdCard (f) ;
        FOR i := 1 TO yExtent DO
          FOR j := 1 TO xExtent DO
          intensity[i][j] := FIO.RdReal (f) ;
          END ;
        END ;
      END ; (* if *)

    END; (* with*)
(*  UNTIL FIO.EOF ;*)
END LoadObjects ;

PROCEDURE DisplayObject (id, sx, sy, color : CARDINAL;
                         scale : REAL ) :BOOLEAN;
VAR
  px , py : ARRAY [0..maxPoints-1] OF CARDINAL ;
  i, j : CARDINAL ;
BEGIN
  WITH object[id] DO
    CASE type OF
      | Polygon :
          FOR i := 1 TO numPoints DO
            px[i-1] := CARDINAL (INTEGER(sx)
                     + VAL(INTEGER, (x[i] * scale + 0.5)) );
            py[i-1] := CARDINAL (INTEGER(sy)
                     + VAL (INTEGER, (y[i] * scale + 0.5)));
          END ;
          Image.Polygon (numPoints, px, py, color) ;
      | Bitmap  :
        FOR i := 1 TO yExtent DO
          FOR j := 1 TO xExtent DO
            Image.Plot (sx + j, sy + i,
                        TRUNC (REAL(color) * intensity[i][j] + 0.5)) ;
          END ;
        END ;
      ELSE
        RETURN FALSE ;
    END ;
  END ;
RETURN TRUE ;
END DisplayObject;

BEGIN
END Objects.
```

5.1.6. Scenario.def

```
DEFINITION MODULE Scenario;
IMPORT FIO ;

PROCEDURE ParseScenario (f : FIO.File) ;

END Scenario.
```

5.1.7. Scenario.mod

```
IMPLEMENTATION MODULE Scenario;

IMPORT Objects, Image, Str, Lib, Sim, IO ;

TYPE
  NoiseType = (UNIFORM, POISSON, NORMAL, LORENTZIAN) ;


PROCEDURE Equal (a, b : ARRAY OF CHAR ) : BOOLEAN ;
BEGIN
  RETURN (Str.Compare (a, b) = 0) ;
END Equal;

PROCEDURE NoiseSource (noise :NoiseType ; power : CARDINAL;
                       x, y : CARDINAL) : CARDINAL ;
BEGIN
  CASE noise OF
    | LORENTZIAN :  RETURN 0;
    | NORMAL :  RETURN TRUNC(ABS(Sim.GaussianDeviation ())
                             * REAL(power) + 0.5);
    | POISSON : RETURN 0;
    | UNIFORM : RETURN Lib.RANDOM (power);
  END ; (* case *)
END NoiseSource ;

PROCEDURE ParseScenario (f : FIO.File) ;
VAR
  dummy : CHAR ;
  noise : NoiseType ;
  token : ARRAY [0..31] OF CHAR ;
  id, x, y, color : CARDINAL ;
  scale, xOffsetReal, yOffsetReal : REAL ;
  endScenario : BOOLEAN ;
  i, j, rep, rep2, x_off, y_off : CARDINAL ;
BEGIN
  endScenario := FALSE ;
  noise := UNIFORM ;
  REPEAT
    FIO.RdItem (f, token) ;
    Str.Caps (token);
    IF    Equal (token, "OBJECT") THEN
      Objects.LoadObjects(f) ;
    ELSIF Equal (token, "PLACE") THEN
      id := FIO.RdCard (f) ;
      x  := FIO.RdCard (f) ;
      y  := FIO.RdCard (f) ;
      color := FIO.RdCard (f) ;
      scale := FIO.RdReal (f) ;
      IF Objects DisplayObject (id, x, y, color, scale) THEN END ;
    ELSIF Equal (token, "REPEAT") THEN
      rep := FIO.RdCard (f) ;
      x_off  := FIO.RdCard (f) ;
      y_off  := FIO.RdCard (f) ;
      FOR i := 1 TO rep - 1 DO
        IF Objects.DisplayObject (id, x+ (x_off*i),
           y+(y_off*i), color, scale) THEN END ;
```

```
    END ;
  ELSIF Equal (token, "ARRAY") THEN
    rep  := FIO.RdCard (f) ;
    rep2 := FIO.RdCard (f) ;
    x_off  := FIO.RdCard (f) ;
    y_off  := FIO.RdCard (f) ;
    FOR i := 0 TO rep - 1 DO
      FOR j := 0 TO rep2 - 1 DO
       IF Objects.DisplayObject (id, x+ (j*x_off), y+(i*y_off),
                                 color, scale) THEN END ;
      END ;
    END ;
  ELSIF Equal (token, "NOISE") THEN
    x  := FIO.RdCard (f) ;
    y  := FIO.RdCard (f) ;
    color := FIO.RdCard (f) ;
    rep  := FIO.RdCard (f) ;
    rep2 := FIO.RdCard (f) ;
    FOR i := 0 TO rep - 1 DO
      FOR j := 0 TO rep2 - 1 DO
        Image.Plot(x+j, y+i, NoiseSource (noise, color, x+j, y+i)) ;
      END ;
    END ;
  ELSIF Equal (token, "GRADIENT") THEN
    x  := FIO.RdCard (f) ;
    y  := FIO.RdCard (f) ;
    color := FIO.RdCard (f) ;
    rep  := FIO.RdCard (f) ;
    rep2 := FIO.RdCard (f) ;
    xOffsetReal  := FIO.RdReal (f) ;
    yOffsetReal  := FIO.RdReal (f) ;
    FOR i := 0 TO rep - 1 DO
      FOR j := 0 TO rep2 - 1 DO
        Image.Plot ((x+ j), (y+i), color + TRUNC(REAL(j)*xOffsetReal + 0.5)
                  + TRUNC(REAL(i)*yOffsetReal + 0.5))  ;
      END ;
    END ;
  ELSIF Equal (token, "LORENTZIAN") THEN
    noise := LORENTZIAN ;
  ELSIF Equal (token, "NORMAL") THEN
    noise := NORMAL ;
  ELSIF Equal (token, "POISSON") THEN
    noise := POISSON ;
  ELSIF Equal (token, "UNIFORM") THEN
    noise := UNIFORM ;
  ELSIF Equal (token, "NEWFRAME") THEN
    Image.NewFrame () ;
  ELSIF Equal (token, "MASK") THEN
    Image.MaskMode := Image.MASK  ;
  ELSIF Equal (token, "UNMASK") THEN
    Image.MaskMode := Image.UNMASK  ;
  ELSIF Equal (token, "NOMASK") THEN
    Image.MaskMode := Image.NOMASK  ;
  ELSIF Equal (token, "ADD") THEN
    Image.PixelMode := Image.ADD  ;
  ELSIF Equal (token, "OVERLAY") THEN
    Image.PixelMode := Image.OVERLAY  ;
  ELSIF Equal (token, "PAUSE") THEN
    dummy := IO.RdKey () ;
  ELSIF Equal (token, "END") THEN
    endScenario := TRUE ;
  END ;

 UNTIL endScenario
END ParseScenario ;
BEGIN
```

```
END Scenario.
```

5.2. Transputer Implementation Source Code (Occam)

SPTest.pgm

```
#INCLUDE "hostio.inc"
#USE "sptest.c8h"
#USE "video.c8h"
#USE "b409stub.c2h"
#USE "buffer.c8h"

--{{{  channels
VAL link0out IS 0 :
VAL link1out IS 1 :
VAL link2out IS 2 :
VAL link3out IS 3 :
VAL link0in  IS 4 :
VAL link1in  IS 5 :
VAL link2in  IS 6 :
VAL link3in  IS 7 :
--}}}
CHAN OF ANY fromAnalog, toAnalog, bufferLink :
CHAN OF ANY fromHost, toGraphics :
CHAN OF SP  fs, ts :

PLACED PAR
  PROCESSOR 0 T8
    PLACE fs AT link0in :
    PLACE ts AT link0out :
    PLACE fromHost AT link2out :
    SPtest (fs, ts, fromHost)

  PROCESSOR 1 T8
    PLACE fromHost AT link1in :
    PLACE bufferLink AT link2out :
    buffer (fromHost, bufferLink)

  PROCESSOR 2 T8
    PLACE bufferLink AT link1in :
    PLACE toGraphics AT link3out :
    buffer (bufferLink, toGraphics)

  PROCESSOR 3 T8
    PLACE toGraphics AT link1in :
    PLACE toAnalog   AT link3out :
    PLACE fromAnalog AT link3in  :
    Video (toGraphics, fromAnalog, toAnalog)

  PROCESSOR 4 T2
    PLACE toAnalog   AT link0in :
    PLACE fromAnalog AT link0out :
    B409.stub ( toAnalog, fromAnalog)
```

SPTest.occ

```
--{{{  #includes and #uses
#INCLUDE "hostio.inc"
#INCLUDE "common.inc"
#USE     "hostio.lib"
#USE     "string.lib"
#USE     "convert.lib"
#USE     "snglmath.lib"
--}}}
PROC SPtest (CHAN OF SP fs, ts, CHAN OF ANY toGraphics )

  --{{{  constants
  VAL debug IS FALSE :

  -- Object types
  VAL UNITIALIZED IS 0 :
  VAL POLYGON IS 1 :
  VAL BITMAP  IS 2 :

  -- Image masking
  VAL NOMASK IS 0 :
  VAL   MASK IS 1 :
  VAL UNMASK IS 2 :

  -- Image Pixel Mode
  VAL OVERLAY IS 0 :
  VAL ADD     IS 1 :

  -- noise types
  VAL UNIFORM    IS 0 :
  VAL NORMAL     IS 0 :
  VAL LORENTZIAN IS 0 :
  VAL POISSON    IS 0 :

  VAL MAXPOINTS IS 32 :
  --}}}
  --{{{  global variables
  VAL maxObj IS 100 :

  [maxObj]INT          object.type :
  [maxObj][32]REAL32   object.x    :
  [maxObj][32]REAL32   object.y    :
  [maxObj]INT          object.numPoints :
  [maxObj]INT          object.xExtent :
  [maxObj]INT          object.yExtent :
  [maxObj][8][8]REAL32 object.intensity :

  INT noiseType, maskMode, pixelMode :
  --}}}
  --{{{  PROCS
  --{{{  utility
  --{{{  FioReadItem
  PROC FioReadItem (CHAN OF SP fs, ts,
                    VAL INT32 streamid,
                    []BYTE data, INT index,
                    BOOL result)
    --{{{  PROC white.space
    BOOL FUNCTION white.space (VAL BYTE c)
      BOOL return :
      VALOF
        SEQ
          CASE c
            ' ', '*c', '*n', '*t'
              return := TRUE
            ELSE
```

```
            return := FALSE
      RESULT return
  :
  --}}}
  [1]BYTE character :
  INT length :
  BOOL continue :
  SEQ
    index := 0
    continue := TRUE
    WHILE continue
      SEQ
        so.read (fs, ts, streamid, length, character)
        IF
          --{{{  no more data
          length = 0
            SEQ
              continue := FALSE
              result := FALSE
          --}}}
          --{{{  leading white space
          white.space (character[0]) AND (index = 0)
            SKIP
          --}}}
          --{{{  termination of string
          white.space (character[0])
            SEQ
              continue := FALSE
              result := TRUE
          --}}}
          --{{{  significant character
          TRUE
            SEQ
              data[index] := character[0]
              index := index + 1
          --}}}
:
--}}}
--{{{  FioReadInt
PROC FioReadInt (CHAN OF SP fs, ts, VAL INT32 streamid,
                 INT value, BOOL result)
  INT length :
  [128]BYTE item :
  BOOL error :
  SEQ
    FioReadItem (fs, ts, streamid, item, length, result)
    IF
      result
        SEQ
          STRINGTOINT (error, value, [item FROM 0 FOR length])
          result := NOT error
      TRUE
        SKIP
:
--}}}
--{{{  FioReadReal32
PROC FioReadReal32 (CHAN OF SP fs, ts, VAL INT32 streamid,
                    REAL32 value, BOOL result)
  INT length :
  [128]BYTE item :
  BOOL error :
  SEQ
    FioReadItem (fs, ts, streamid, item, length, result)
    IF
      result
        SEQ
          STRINGTOREAL32 (error, value, [item FROM 0 FOR length],
```

```
          result := NOT error
      TRUE
        SKIP
:
--}}}
--}}}
--{{{  image
--{{{  PROC UpdateModes
PROC UpdateModes ()
  SEQ
    toGraphics ! 2 ; c.pixel.mode; pixelMode
    toGraphics ! 2 ; c.mask.mode; maskMode
:
--}}}
--{{{  PROC Plot
PROC Plot (VAL INT x, y, color)
  SEQ
    toGraphics ! 4; c.plot; x ; y; color
:
--}}}
--{{{  PROC NoiseSource
PROC NoiseSource (INT noise, VAL INT noiseType, magnitude, x, y,
                  INT32 seed)
  REAL32 random :
  SEQ
    random, seed := RAN (seed)
    noise := INT ROUND ((REAL32 TRUNC magnitude) * random)
:
--}}}
--{{{  PROC HLine
PROC HLine (VAL INT x0, y, x1, color)
  SEQ
    WHILE debug
      SEQ
        so.write.int (fs, ts, y, 6)
        so.write.int (fs, ts, x0, 6)
        so.write.string (fs, ts, "--")
        so.write.int (fs, ts, x1, 6)
        so.write.int (fs, ts, color, 6)
        so.write.nl (fs, ts)
    toGraphics ! 6; c.line; x0; y; x1; y; color
:
--}}}
--{{{  PROC Sort
PROC Sort ([]INT x, xord, VAL INT first, last)
  IF
    first < last
      --{{{  okay to sort
      INT check, next :
      INT v1, v2 :
      SEQ
        SEQ check = first FOR (last - first)
          SEQ
            next := check + 1
            v1 := x[xord[check]]
            WHILE next <= last
              SEQ
                v2 := x[xord[next]]
                IF
                  v2 < v1
                    --{{{  switch indexes
                    INT temp :
                    SEQ
                      v1 := v2
                      temp := xord[next]
                      xord[next] := xord[check]
                      xord[check] := temp
```

```
                --}}}
              TRUE
                SKIP
            next := next + 1
      --}}}
    TRUE
      SKIP
:
--}}}
--{{{  PROC Polygon
PROC Polygon (VAL []INT px, py, VAL INT n, color)

  --{{{  variables
  INT miny, maxy, nextEdge, active :
  [32]INT xord, x, e :
  --}}}
  SEQ
    --{{{  find extemal y points
    miny := py[0]
    maxy := miny
    SEQ i = 0 FOR n
      VAL test IS py[i] :
      IF
        test < miny
          miny := test
        test > maxy
          maxy := test
        TRUE
          SKIP
    --}}}
    SEQ y = miny FOR ((maxy - miny) + 1)
      SEQ
        --{{{  debug
        WHILE debug
          SEQ
            so.write.string(fs, ts, " y=")
            so.write.int   (fs, ts, y, -5)
            so.write.nl (fs, ts)
        --}}}
        active := (-1)
        INT x0, x1, y0, y1 :
        SEQ edge = 0 FOR n
          SEQ
            --{{{  debug
            WHILE debug
              SEQ
                so.write.string(fs, ts, " edge=")
                so.write.int   (fs, ts, edge, -5)
                so.write.nl (fs, ts)
            --}}}
            --{{{  calculate nextEdge
            IF
              edge = (n - 1)
                nextEdge := 0
              TRUE
                nextEdge := edge + 1
            --}}}
            --{{{  assign start and end points
            x0 := px[edge]
            y0 := py[edge]
            x1 := px[nextEdge]
            y1 := py[nextEdge]
            --}}}
            --{{{  reverse if necessary
            IF
              y0 > y1
                INT temp:
```

```
    SEQ
      temp := x0
      x0   := x1
      x1   := temp
      temp := y0
      y0   := y1
      y1   := temp
  TRUE
    SKIP
--}}}
--{{{  process
IF
  y = y0
    --{{{
    SEQ
      e[edge] := 0
      x[edge] := x0
      --{{{  increment active
      IF
        y = miny
          SEQ
            active := active + 1
            xord[active] := edge
        TRUE
          SKIP
      --}}}
      --{{{  debug
      WHILE debug
        SEQ
          so.write.string(fs, ts, "y = y0      ")
          so.write.string(fs, ts, " e[edge]=")
          so.write.int   (fs, ts, e[edge], -5)
          so.write.string(fs, ts, " x[edge]=")
          so.write.int   (fs, ts, x[edge], -5)
          so.write.nl (fs, ts)
      --}}}
    --}}}
  (y0 < y) AND (y <= y1)
    --{{{
    SEQ
      IF
        --{{{  x increases with y
        x1 >= x0
          SEQ
            e[edge] := e[edge] + (2 * (x1 - x0))
            WHILE (e[edge] > (y1 - y0))
              SEQ
                e[edge] := e[edge] - (2 * (y1 - y0))
                x[edge] := x[edge] + 1
            --{{{  debug
            WHILE debug
              SEQ
                so.write.string(fs, ts, "x1 >= x0      ")
                so.write.string(fs, ts, " e[edge]=")
                so.write.int   (fs, ts, e[edge], -5)
                so.write.string(fs, ts, " x[edge]=")
                so.write.int   (fs, ts, x[edge], -5)
                so.write.nl (fs, ts)
            --}}}
        --}}}
        --{{{  x decreases with y
        TRUE
          SEQ
            e[edge] := e[edge] + (2 * (x0 - x1))
            WHILE (e[edge] > (y1 - y0))
              SEQ
                e[edge] := e[edge] - (2 * (y1 - y0))
```

```
                    x[edge] := x[edge] - 1
                  --{{{  debug
                  WHILE debug
                    SEQ
                      so.write.string(fs, ts, "x1 <  x0     ")
                      so.write.string(fs, ts, " e[edge]=")
                      so.write.int   (fs, ts, e[edge], -5)
                      so.write.string(fs, ts, " x[edge]=")
                      so.write.int   (fs, ts, x[edge], -5)
                      so.write.nl (fs, ts)
                  --}}}
                --}}}
              --{{{  increment active
              active := active + 1
              xord[active] := edge
              --}}}
            --}}}
          TRUE
            SKIP
        --}}}
      --{{{  sort and plot
      Sort (x, xord, 0, active)
      INT i :
      SEQ
        i := 0
        WHILE i < active
          SEQ
            HLine (x[xord[i]], y, x[xord[i+1]], color)
            i := i + 2
      --}}}

:
--}}}
--}}}

--{{{  Objects module
--{{{  LoadObjects
PROC LoadObjects (CHAN OF SP fs, ts, VAL INT32 streamid)
  --{{{  check result
  PROC check.result (CHAN OF SP fs, ts, VAL BOOL value, VAL []BYTE message)
    IF
      value
        SKIP
      TRUE
        so.write.string.nl (fs, ts, message)
  :
  --}}}
  BOOL ok :
  INT  id, length :
  [128]BYTE id.name :
  SEQ
    ok := TRUE
    WHILE ok
      SEQ
        FioReadInt (fs, ts, streamid, id, ok)
        FioReadItem (fs, ts, streamid, id.name, length, ok)
        to.upper.case (id.name)
        IF
          --{{{  POLYGON
          eqstr ([id.name FROM 0 FOR length], "POLYGON")
            SEQ
              object.type[id] := POLYGON
              so.write.string (fs, ts, "polygon                    *c")
              FioReadInt (fs, ts, streamid, object.numPoints[id], ok)
              check.result (fs, ts, ok, "--Error reading numPoints")
              SEQ i = 0 FOR object.numPoints[id]
                SEQ
```

```
                    FioReaLReal32 (fs, ts, streamid, object.x[id][i], ok)
                    check.result (fs, ts, ok, "--Error reading x")
                    FioReadReal32 (fs, ts, streamid, object.y[id][i], ok)
                    check.result (fs, ts, ok, "--Error reading y")
                    --so.write.char (fs, ts, '.')
            --}}}
            --{{{  BITMAP
            eqstr ([id.name FROM 0 FOR length], "BITMAP")
              SEQ
                object.type[id] := BITMAP
                so.write.string (fs, ts, "bitmap                    *c")
                FioReadInt (fs, ts, streamid, object.xExtent[id], ok)
                check.result (fs, ts, ok, "--Error reading xExtent")
                FioReadInt (fs, ts, streamid, object.yExtent[id], ok)
                check.result (fs, ts, ok, "--Error reading yExtent")
                SEQ i = 0 FOR object.yExtent[id]
                  SEQ
                    SEQ j = 0 FOR object.xExtent[id]
              SEQ[ PrinterErrorEQ
                      --so.write.char (fs, ts, '.')
                      FioReadReal32 (fs, ts, streamid,
object.intensity[id][i][j], ok)
                      check.result (fs, ts, ok, "--Error reading intensity")
            --}}}
            TRUE
              ok := FALSE
  :

  --}}}
  --{{{  DisplayObject
  PROC DisplayObject (VAL INT id, sx, sy, color, VAL REAL32 scale)
    [MAXPOINTS]INT x, y :
    SEQ
      UpdateModes ()
      CASE object.type[id]
        POLYGON
          SEQ
            SEQ i = 0 FOR object.numPoints[id]
              SEQ
                x[i] := (INT TRUNC (scale * object.x[id][i])) + sx
                y[i] := (INT TRUNC (scale * object.y[id][i])) + sy
            Polygon (x, y, object.numPoints[id], color)
        BITMAP
          SEQ
            SEQ i = 0 FOR object.yExtent[id]
              SEQ j = 0 FOR object.xExtent[id]
                Plot (sx + j, sy + i, INT ROUND ((REAL32 TRUNC color) *
                      object.intensity[id][i][j]) )
        ELSE
          SKIP
  :
  --}}}
  --}}}
  --{{{  Scenario module
  --{{{  ParseScenario
  PROC ParseScenario (VAL INT32 streamid)
    --{{{  variables
    BOOL endScenario :
    INT  id, x, y, color, repeat, repeat2, x.offset, y.offset :
    REAL32 scale :
    BOOL result :
    [128]BYTE long.token :
    INT32 seed :
    --}}}
    SEQ
      seed := 3245 (INT32)
      endScenario := FALSE
```

```
noiseType := UNIFORM
maskMode := NOMASK
pixelMode := OVERLAY
WHILE NOT endScenario
  INT length :
  BOOL ok :
  SEQ
    FioReadItem (fs, ts, streamid, long.token, length, result)
    token IS [long.token FROM 0 FOR length] :
    IF
      --{{{  placements
      --{{{  PLACE
      eqstr (token, "PLACE" )
        SEQ
          so.write.string (fs, ts, "place              *c")
          FioReadInt (fs, ts, streamid, id, ok)
          FioReadInt (fs, ts, streamid, x, ok)
          FioReadInt (fs, ts, streamid, y, ok)
          FioReadInt (fs, ts, streamid, color, ok)
          FioReadReal32 (fs, ts, streamid, scale, ok)
          DisplayObject (id, x, y, color, scale)
      --}}}
      --{{{  REPEAT
      eqstr (token, "REPEAT")
        SEQ
          so.write.string (fs, ts, "repeat               *c")
          FioReadInt (fs, ts, streamid, repeat, ok)
          FioReadInt (fs, ts, streamid, x.offset, ok)
          FioReadInt (fs, ts, streamid, y.offset, ok)
          SEQ i = 1 FOR (repeat - 1)
            DisplayObject (id, x + (x.offset * i),
                           y + (y.offset * i), color, scale)
      --}}}
      --{{{  ARRAY
      eqstr (token, "ARRAY")
        SEQ
          so.write.string (fs, ts, "array                *c")
          FioReadInt (fs, ts, streamid, repeat, ok)
          FioReadInt (fs, ts, streamid, repeat2, ok)
          FioReadInt (fs, ts, streamid, x.offset, ok)
          FioReadInt (fs, ts, streamid, y.offset, ok)
          SEQ i = 0 FOR repeat
            SEQ j = 0 FOR repeat2
              IF
                (i = 0) AND (j = 0)
                  SKIP
                TRUE
                  DisplayObject (id, x + (x.offset * j),
                                 y + (y.offset * i), color, scale)
      --}}}
      --}}}
      --{{{  backgrounds
      --{{{  NOISE
      eqstr (token, "NOISE")
        SEQ
          so.write.string (fs, ts, "noise                *c")
          FioReadInt (fs, ts, streamid, x, ok)
          FioReadInt (fs, ts, streamid, y, ok)
          FioReadInt (fs, ts, streamid, color, ok)
          FioReadInt (fs, ts, streamid, repeat, ok)
          FioReadInt (fs, ts, streamid, repeat2, ok)
          UpdateModes ()
          SEQ i = 0 FOR repeat
            SEQ j = 0 FOR repeat2
              INT n :
              SEQ
                NoiseSource (n, noiseType, color, x + j, y + i, seed)
```

```
                    Plot (x + j, y + i, n)
              --}}}
              --{{{  GRADIENT
              eqstr (token, "GRADIENT")
                REAL32 x.offset.real :
                REAL32 y.offset.real :
                SEQ
                  so.write.string (fs, ts, "gradient              *c")
                  FioReadInt (fs, ts, streamid, x, ok)
                  FioReadInt (fs, ts, streamid, y, ok)
                  FioReadInt (fs, ts, streamid, color, ok)
                  FioReadInt (fs, ts, streamid, repeat, ok)
                  FioReadInt (fs, ts, streamid, repeat2, ok)
                  FioReadReal32 (fs, ts, streamid, x.offset.real, ok)
                  FioReadReal32 (fs, ts, streamid, y.offset.real, ok)
                  UpdateModes ()
                  SEQ i = 0 FOR repeat
                    SEQ j = 0 FOR repeat2
                      INT newColor :
                      SEQ
                        newColor := color + ((INT TRUNC ( (REAL32 TRUNC j) *
                                                          (x.offset.real + 0.5
(REAL32) ))) +
                                             (INT TRUNC ( (REAL32 TRUNC i) *
                                                          (y.offset.real + 0.5
(REAL32) ))))
                        Plot (x + j, y + i, newColor )
              --}}}
              --}}}
              --{{{  noise models
              eqstr (token, "LORENTZIAN")
                noiseType := LORENTZIAN
              eqstr (token, "NORMAL")
                noiseType := NORMAL
              eqstr (token, "UNIFORM")
                noiseType := UNIFORM
              eqstr (token, "POISSON")
                noiseType := POISSON
              --}}}
              --{{{  masks
              eqstr (token, "MASK")
                maskMode := MASK
              eqstr (token, "UNMASK")
                maskMode := UNMASK
              eqstr (token, "NOMASK")
                maskMode := NOMASK
              --}}}
              --{{{  pixel construction
              eqstr (token, "ADD")
                pixelMode := ADD
              eqstr (token, "OVERLAY")
                pixelMode := OVERLAY
              --}}}
              --{{{  time and frame manipulation
              eqstr (token, "NEWFRAME")
                --NewFrame ()
                SKIP
              eqstr (token, "PAUSE")
                SEQ
                  so.write.string (fs, ts,   "Paused  -- hit any key to continue.")
                  BYTE key, result :
                  so.getkey (fs, ts, key, result)
                  so.write.string (fs, ts, "*c
*c")
              eqstr (token, "END")
                endScenario := TRUE
              --}}}
```

```
            --{{{  unrecognized token
            TRUE
              SEQ
                so.write.string (fs, ts, "Unrecognized token *'")
                so.write.string (fs, ts, token)
                so.write.string.nl (fs, ts, "*'")
                endScenario := TRUE
            --}}}
:
--}}}
--}}}

--}}}

--{{{  variables
BYTE result :
INT32 streamid :
[128]BYTE buffer :
INT length :
BOOL ok :
[32]INT temp, tempord :
--}}}
SEQ
  so.open (fs, ts, "objects.dat", spt.text, spm.input, streamid, result)
  --{{{  load object data file
  IF
    result = spr.ok
      SEQ
        LoadObjects (fs, ts, streamid)
        so.close (fs, ts, streamid, result)
    TRUE
      SKIP
  --}}}
  --{{{  parse scenario
  IF
    result = spr.ok
      SEQ
        so.open (fs, ts, "scene.dat",
                 spt.text, spm.input, streamid, result)
        ParseScenario (streamid)
        so.close (fs, ts, streamid, result)
    TRUE
      SKIP
  --}}}
  so.exit (fs, ts, 0 (INT32))
:
```

Buffer.occ

```
PROC buffer (CHAN OF ANY in, out)
  [2]INT length :
  [2][256]INT command :
  INT send, receive :
  SEQ
    receive := 0
    in ? length[receive]::command[receive]
    WHILE TRUE
      SEQ
        send    := receive
        receive := 1 - receive
        PAR
          in ? length[receive]::command[receive]
          out ! length[send]::command[send]
:
```

G_Line.occ

```
--{{{  SC line
--:::A  3 10
--{{{  line
--{{{  libraries
#INCLUDE "g_header.inc"
--}}}
--{{{  plot
PROC plot ( VAL [] INT window, [] BYTE screen,
            VAL INT x, y, VAL BYTE color )

  -- plots a single point on the screen
  -- makes sure the pixels are actually in the window
  VAL pixels.line IS window[ w.pixels.line ] :
  VAL size.x      IS window[ w.size.x ] :
  VAL size.y      IS window[ w.size.y ] :
  SEQ
    IF
      (x < 0) OR (y < 0) OR (x >= size.x) OR (y >= size.y)
        SKIP
      TRUE
        screen[ (y * pixels.line) + x ] := color
:
--}}}
--{{{  draw.line
PROC draw.line ( VAL [] INT window, [] BYTE screen,
                 VAL INT x1, y1, x2, y2,
                 VAL BYTE color )

  --{{{  clip.line
  PROC clip.line (VAL INT x1, y1, x2, y2, INT result, VAL []INT window)
    -- decides whether a line is totally on or off screen/window
    --{{{  codes
    VAL code.centre IS #00 :        -- 0000
    VAL code.left   IS #01 :        -- 0001
    VAL code.right  IS #02 :        -- 0010
    VAL code.bottom IS #04 :        -- 0100
    VAL code.top    IS #08 :        -- 1000
    --}}}
    INT code1, code2 :
    --{{{  PROC check
    PROC check (VAL INT x, y, INT code)
      VAL x.max IS window[ w.size.x ] :
      VAL y.max IS window[ w.size.y ] :
      SEQ
        IF
          --{{{  x.min <= x < x.max
          (x >= 0) AND (x < x.max)
            code := code.centre
          --}}}
          --{{{  x < x.min
          x < 0
            code := code.left
          --}}}
          --{{{  x > x.max
          TRUE --x >= x.max
            code := code.right
          --}}}
        IF
          --{{{  y.min <= y < y.max
          (y >= 0) AND (y < y.max)
            SKIP
          --}}}
          --{{{  y < y.min
          y < 0
```

```
          code := code \/ code.top
        --}}}
        --{{{  y >= y.max
        TRUE --y > y.max
          code := code \/ code.bottom
        --}}}
  :
  --}}}
  SEQ
    check (x1, y1, code1)
    check (x2, y2, code2)
    IF
      --{{{  line lies entirely within window
      (code1 \/ code2) = 0
        result := in.range
      --}}}
      --{{{  line lies entirely outside window
      (code1 /\ code2) <> 0
        result := not.inrange
      --}}}
      --{{{  partially in window perhaps
      TRUE
        result := part.inrange
      --}}}
:
--}}}
--{{{  slow.draw.line
PROC slow.draw.line ( VAL [] INT window, [] BYTE screen,
                      VAL INT x1, y1, x2, y2,
                      VAL BYTE color )
  -- uses Bresenham's integer algorithm to calculate plotting points
  -- calls plot to draw actual pixels on the screen
  VAL pixels.line IS window[w.pixels.line] :
  INT dx, dy :
  INT two.dx, two.dy :
  INT error :
  SEQ
    dx := x2 - x1
    dy := y2 - y1
    IF
      (dx <> 0) OR (dy <> 0)
        SEQ
          --{{{  a line to draw
          IF
            --{{{  dy = 0                -- horizontal line
            dy = 0
              SEQ i = x1 FOR dx + 1
                plot (window, screen, i, y1, color)
            --}}}
            --{{{  dx = 0                -- vertical line
            dx = 0
              SEQ
                IF
                  dy > 0
                    SEQ i = y1 FOR dy + 1
                      plot (window, screen, x1, i, color)
                  TRUE
                    SEQ i = y2 FOR (-dy) + 1
                      plot (window, screen, x1, i, color)
            --}}}
            --{{{  dx <> 0  dy <> 0      -- diagonal line
            TRUE
              INT x, y :
              INT delta.y :
              SEQ
                x := x1
                y := y1
```

```
two.dx := dx + dx
IF
  --{{{  dy > 0
  dy > 0
    SEQ
      two.dy := dy + dy
      IF
        --{{{  dy > dx
        dy > dx
          SEQ
            error := two.dx - dy
            --{{{  plot line
            SEQ i = 0 FOR dy + 1
              SEQ
                plot (window, screen, x, y, color )
                IF
                  error >= 0
                    SEQ
                      x := x + 1
                      error := error - two.dy
                  TRUE
                    SKIP
                y := y + 1
                error := error + two.dx
            --}}}
        --}}}
        --{{{  dy <= dx
        TRUE
          SEQ
            error := two.dy - dx
            --{{{  plot line
            SEQ i = 0 FOR dx + 1
              SEQ
                plot (window, screen, x, y, color )
                IF
                  error >= 0
                    SEQ
                      y := y + 1
                      error := error - two.dx
                  TRUE
                    SKIP
                x := x + 1
                error := error + two.dy
            --}}}
      --}}}
  --{{{  dy < 0
  TRUE
    SEQ
      dy := -dy
      two.dy := dy + dy
      IF
        --{{{  dy > dx
        dy > dx
          SEQ
            error := two.dx - dy
            --{{{  plot line
            SEQ i = 0 FOR dy + 1
              SEQ
                plot (window, screen, x, y, color)
                IF
                  error >= 0
                    SEQ
                      x := x + 1
                      error := error - two.dy
                  TRUE
                    SKIP
```

```
                                y := y - 1
                                error := error + two.dx
                            --}}}
                        --}}}
                        --{{{  dy <= dx
                        TRUE
                          SEQ
                            error := two.dy - dx
                            SEQ i = 0 FOR dx + 1
                              SEQ
                                plot (window, screen, x, y, color)
                                IF
                                  error >= 0
                                    SEQ
                                      y := y - 1
                                      error := error - two.dx
                                  TRUE
                                    SKIP
                                x := x + 1
                                error := error + two.dy
                        --}}}
                    --}}}
                --}}}
            --}}}
        TRUE
          plot (window, screen, x1, y1, color)
:
--}}}
--{{{  fast.draw.line
PROC fast.draw.line (VAL [] INT window, [] BYTE screen,
                     VAL INT x1, y1, x2, y2,
                     VAL BYTE  color)

  -- uses Bresenham's integer algorithm to calculate plotting points
  -- points are in increasing values of x
  -- only called when the line is known to be on screen / in window and
  -- the current pixel size is one
  INT dx, dy, two.dx, two.dy, delta.x, delta.y :
  INT error, pixel :
  VAL pixels.line IS window[ w.pixels.line ] :
  SEQ
    dx := x2 - x1               -- always zero or positive
    dy := y2 - y1
    pixel := (y1 * pixels.line) + x1
    IF
      (dx <> 0) OR (dy <> 0)
        SEQ
          --{{{  a line to draw
          IF
            --{{{  dy = 0               -- horizontal line
            dy = 0
              SEQ i = pixel FOR dx + 1
                screen[i] := color
            --}}}
            --{{{  dx = 0               -- vertical line
            dx = 0
              SEQ
                IF
                  dy > 0
                    SEQ i = 0 FOR dy + 1
                      SEQ
                        screen[pixel] := color
                        pixel := pixel + pixels.line
                  TRUE
                    SEQ i = 0 FOR (-dy) + 1
                      SEQ
                        screen[pixel] := color
```

```
                    pixel := pixel - pixels.line
            --}}}
            --{{{  dx <> 0 AND dy <> 0
            TRUE
              INT delta.y :
              SEQ
                two.dx := dx + dx
                IF
                  dy > 0
                    delta.y := pixels.line
                  TRUE
                    SEQ
                      dy := -dy
                      delta.y := -pixels.line
                two.dy := dy + dy
                IF
                  --{{{  dy > dx
                  dy > dx
                    SEQ
                      error := two.dx - dy
                      --{{{  plot line
                      SEQ i = 0 FOR dy + 1
                        SEQ
                          screen[pixel] := color
                          IF
                            error >= 0
                              SEQ
                                pixel := pixel + 1
                                error := error - two.dy
                            TRUE
                              SKIP
                          pixel := pixel + delta.y
                          error := error + two.dx
                      --}}}
                  --}}}
                  --{{{  dy <= dx
                  TRUE
                    SEQ
                      error := two.dy - dx
                      --{{{  plot line
                      SEQ i = 0 FOR dx + 1
                        SEQ
                          screen[pixel] := color
                          IF
                            error >= 0
                              SEQ
                                pixel := pixel + delta.y
                                error := error - two.dx
                            TRUE
                              SKIP
                          pixel := pixel + 1
                          error := error + two.dy
                      --}}}
                  --}}}
          --}}}
        --}}}
      TRUE
        screen[pixel] := color
:
--}}}
INT x3, y3, x4, y4 :
INT result :
SEQ
  --{{{  swap x1,y1 with x2,y2 if x1 > x2
  IF
    x1 > x2
      SEQ
```

```
          x3 := x2
          y3 := y2
          x4 := x1
          y4 := y1
      TRUE
        SEQ
          x3 := x1
          y3 := y1
          x4 := x2
          y4 := y2
    --}}}
    clip.line (x3, y3, x4, y4, result, window)
    IF
      (result = in.range)
        fast.draw.line (window, screen, x3, y3, x4, y4, color)
      (result = part.inrange) OR (result = in.range)
        slow.draw.line (window, screen, x3, y3, x4, y4, color)
      TRUE
        SKIP
:
--}}}
--{{{  draw.polyline
PROC draw.polyline ( VAL [] INT window, [] BYTE screen,
                     VAL [][2]INT points, VAL BYTE color)

  -- calls draw line to draw the lines
  INT x, y :
  SEQ
    x := points[0][0]
    y := points[0][1]
    SEQ i = 1 FOR (SIZE points) - 1
      VAL point IS points[i] :
      SEQ
        draw.line( window, screen, x, y, point[0], point[1], color )
        x := point[0]
        y := point[1]
:
--}}}
--{{{  draw.rectangle
PROC draw.rectangle ( VAL [] INT window, [] BYTE screen,
                      VAL [2][2]INT p, VAL BYTE color)

  -- calls draw line to draw the lines
  INT x, y :
  SEQ
    draw.line( window, screen, p[0][0], p[0][1], p[1][0], p[0][1], color )
    draw.line( window, screen, p[1][0], p[0][1], p[1][0], p[1][1], color )
    draw.line( window, screen, p[1][0], p[1][1], p[0][0], p[1][1], color )
    draw.line( window, screen, p[0][0], p[1][1], p[0][0], p[0][0], color )
:
--}}}
--}}}
--}}}
```

G_System.occ

```
--{{{  SC system
--:::A  3 10
--{{{  system
--{{{  libraries
#INCLUDE "crtc.inc"
#INCLUDE "g_header.inc"
--}}}
--{{{  set.colour
PROC set.colour ( CHAN OF CRTC message,
                  VAL INT channel, pixel, red, green, blue )
  -- set up a colour in the G170 colour look up table
  SEQ
    message ! crtc.color; INT16 channel; INT16 pixel;
                          INT16 red; INT16 green; INT16 blue
:
--}}}
--{{{  set.timing
PROC set.timing( CHAN OF CRTC message,
                 VAL INT width,height, line.frequency, frame.rate, pixel.clock,
                 VAL BOOL interlace )

  SEQ
    message ! crtc.init; INT16 width; INT16 height; INT32 line.frequency;
              INT16 frame.rate; INT32 pixel.clock; interlace
:
--}}}
--{{{  set.B408
PROC set.B408( VAL INT DS, IE, EM, OE, R )

  --{{{  system constants
  VAL bpw.shift IS 2 :
  VAL mint      IS MOSTNEG INT :

  VAL DisplayStart.address    IS (#00000000   >< mint) >> bpw.shift :
  VAL InterlaceEnable.address IS (#000C0000   >< mint) >> bpw.shift :
  VAL EventMode.address       IS (#00100000   >< mint) >> bpw.shift :
  VAL OutputEnable.address    IS (#00140000   >< mint) >> bpw.shift :
  VAL Ready.address           IS (#00040000   >< mint) >> bpw.shift :

  INT DisplayStart, InterlaceEnable, EventMode, OutputEnable, Ready :

  PLACE  DisplayStart      AT  DisplayStart.address    :
  PLACE  InterlaceEnable   AT  InterlaceEnable.address :
  PLACE  EventMode         AT  EventMode.address       :
  PLACE  OutputEnable      AT  OutputEnable.address    :
  PLACE  Ready             AT  Ready.address           :
  --}}}
  SEQ
    DisplayStart := DS
    InterlaceEnable := IE
    EventMode := EM
    OutputEnable := OE
    Ready := R
:
--}}}
--{{{  init.G170
PROC init.G170 (CHAN OF CRTC message, VAL INT channel, table)

  SEQ
    message ! crtc.initLUT; INT16 channel; INT16 table
:
--}}}
--{{{  clear.window
PROC clear.window (VAL [] INT window, [] BYTE screen)

  VAL size.x       IS  window[ w.size.x ] :
```

```
  VAL size.y       IS  window[ w.size.y ] :
  VAL pixels.line  IS  window[ w.pixels.line ] :
  VAL b.color      IS  BYTE window[ w.background.color ] :
  INT ptr :
  SEQ
    SEQ i = 0 FOR size.x
      screen[i] := b.color
    ptr := pixels.line
    SEQ i = 0 FOR size.y - 1
      SEQ
        [screen FROM ptr FOR size.x] := [screen FROM 0 FOR size.x]
        ptr := ptr + pixels.line
:
--}}}
--}}}
--}}}
```

G_Text.occ

```
--{{{  SC text
--:::A  3 10
--{{{  text
#INCLUDE "g_header.inc"
--{{{  FUNCTION GetINT
INT FUNCTION GetINT (VAL INT pointer, VAL [] INT table)
  INT return :
  VAL [] BYTE b.table RETYPES table :
  VALOF
    [4]BYTE return.b RETYPES return :
    SEQ
      return.b[0] := b.table[pointer]
      return.b[1] := b.table[pointer + 1]
      return.b[2] := b.table[pointer + 2]
      return.b[3] := b.table[pointer + 3]
    RESULT return
:
--}}}
--{{{  FUNCTION GetINT16
INT16 FUNCTION GetINT16 (VAL INT pointer, VAL [] INT table)
  INT16 return :
  VAL [] BYTE b.table RETYPES table :
  VALOF
    [2]BYTE return.b RETYPES return :
    SEQ
      return.b[0] := b.table[pointer]
      return.b[1] := b.table[pointer + 1]
    RESULT return
:
--}}}
--{{{  FUNCTION GetBYTE
BYTE FUNCTION GetBYTE (VAL INT pointer, VAL [] INT table)
  BYTE return :
  VAL [] BYTE b.table RETYPES table :
  VALOF
    SEQ
      return := b.table[pointer]
    RESULT return
:
--}}}
--{{{  get.font.spec
PROC get.font.spec ( VAL [] INT font, [fs.size] INT spec)

  SEQ
    spec[ fs.PixWidth   ] := INT (GetINT16 (dfPixWidth.p,  font))
    spec[ fs.PixHeight  ] := INT (GetINT16 (dfPixHeight.p, font))
    spec[ fs.FirstChar  ] := INT (GetBYTE  (dfFirstChar.p, font))
    spec[ fs.LastChar   ] := INT (GetBYTE  (dfLastChar.p,  font))
    spec[ fs.BitsOffset ] :=      GetINT   (dfBitsOffset.p,font)
:
--}}}
--{{{  scroll
PROC scroll ( VAL [] INT window, []BYTE screen,
              VAL INT jump.size )
  -- scrolls a screen or window by the requ red number of lines (jump.size)
  VAL size.x      IS  window[ w.size.x ] :
  VAL size.y      IS  window[ w.size.y ] :
  VAL pixels.line IS  window[ w.pixels.line ] :
  VAL b.color     IS  BYTE window[ w.background.color ] :
  INT p1, p2 :
  IF
    (jump.size > 0) AND (jump.size < size.y)
      --{{{  scroll screen
      SEQ
```

```
          p1 := 0
          p2 := pixels.line * jump.size
          SEQ i = 0 FOR (size.y - jump.size)
            SEQ
              [screen FROM p1 FOR size.x] := [screen FROM p2 FOR size.x]
              p1 := p1 + pixels.line
              p2 := p2 + pixels.line
          SEQ i = 0 FOR size.x
            screen[ p1 + i ] := b.color
          p2 := p1 + pixels.line
          SEQ i = 0 FOR (jump.size - 1)
            SEQ
              [screen FROM p2 FOR size.x] := [screen FROM p1 FOR size.x]
              p2 := p2 + pixels.line
        --}}}
      jump.size > 0
        --{{{  clear screen
        SEQ

          SEQ i = 0 FOR size.x
            screen[ i ] := b.color
          p2 := pixels.line
          SEQ i = 0 FOR (jump.size - 1)
            SEQ
              [screen FROM p2 FOR size.x] := [screen FROM 0 FOR size.x]
              p2 := p2 + pixels.line
        --}}}
      TRUE
        SKIP
:
--}}}
--{{{  draw.char  v2.0
PROC draw.char ( [] INT window, [] BYTE screen,
                 VAL BYTE char,
                 VAL [] INT font, VAL [fs.size] INT spec )

  --{{{  constants
  VAL mask IS 1 << 7 :
  pixels.line IS window[ w.pixels.line ] :
  size.x      IS window[ w.size.x      ] :
  size.y      IS window[ w.size.y      ] :
  cursor.x    IS window[ w.cursor.x    ] :
  cursor.y    IS window[ w.cursor.y    ] :

  VAL [] BYTE b.font RETYPES font :
  --}}}
  --{{{  variables
  INT bit, pixel :
  INT bitmask :
  INT char.width, offset, PixWidthBytes :
  INT char.spacing :
  INT character :
  --}}}
  --{{{  line feed
  PROC line.feed ( )

    SEQ
      cursor.y := cursor.y + spec[ fs.PixHeight ]
      IF
        (cursor.y + spec[ fs.PixHeight ]) < size.y
          SKIP
        TRUE
          INT scroll.lines :
          SEQ
            scroll.lines := (spec[ fs.PixHeight ] - (size.y - cursor.y)) + 1
            cursor.y := (size.y - spec[ fs.PixHeight ]) - 1
            scroll( window, screen, scroll.lines )
```

```
  :
  --}}}
  SEQ
    character := INT char
    IF
      char = '*n'
        line.feed ()
      char = '*c'
        --{{{  carriage return
        cursor.x := 0
        --}}}
      (character >= spec[ fs.FirstChar ]) AND (character <= spec[ fs.LastChar])
        SEQ
          character := character - spec[ fs.FirstChar ]
          --{{{  set font data
          IF
            spec[ fs.PixWidth ] <> 0                                -- Fixed Width
              SEQ
                PixWidthBytes  := (spec[ fs.PixWidth ] + 7) >> 3
                char.width     := spec[ fs.PixWidth ]
                offset         := (character * (PixWidthBytes * spec[ fs.PixHeight
]]) +
                                      spec[ fs.BitsOffset ]
                char.spacing   := char.width
            TRUE                                                    -- Variable Width
              INT char.width.p, char.pointer.p :
              SEQ
                char.width.p   := CharTable.p + (character << 2)
                char.pointer.p := char.width.p + 2
                char.width     := INT(GetINT16(char.width.p, font))
                offset         := INT(GetINT16(char.pointer.p, font))
                PixWidthBytes  := (char.width + 7) >> 3
                char.spacing   := char.width + 1
          --}}}
          IF
            --{{{  char too big
            (char.width > size.x) OR (spec[ fs.PixHeight ] > size.y)
              SKIP
            --}}}
            --{{{  room to draw char
            BOOL delayed.crlf :
            TRUE
              SEQ
                delayed.crlf := FALSE
                IF
                  --{{{  room to draw whole char
                  ((cursor.x + char.spacing) < size.x) AND
                      ((cursor.y + spec[ fs.PixHeight ]) < size.y)
                    SKIP
                  --}}}
                  --{{{  room to draw but at end of line
                  ((cursor.x + char.spacing) = size.x) AND
                      ((cursor.y + spec[ fs.PixHeight ]) < size.y)
                    delayed.crlf := TRUE
                  --}}}
                  --{{{  we need carriage return - line feed
                  TRUE
                    SEQ
                      cursor.x := 0
                      line.feed ()
                  --}}}
                pixel := (cursor.y TIMES pixels.line) + cursor.x
                --{{{  plot foreground only
                VAL f.color IS BYTE window[ w.foreground.color ] :
                SEQ
                  SEQ i = 0 FOR spec[ fs.PixHeight ]
                    SEQ
```

```
                    --{{{  draw row
                    SEQ j = 0 FOR PixWidthBytes
                      SEQ
                        bitmask := mask
                        VAL this.byte IS INT b.font[ offset+((spec[fs.PixHeight]
TIMES j) + i) ] :
                        SEQ k = 0 FOR 8
                          SEQ
                            bit := this.byte /\ bitmask
                            IF
                              --{{{  leave background as it is
                              bit = 0
                                SKIP
                              --}}}
                              --{{{  plot foreground bit
                              TRUE
                                screen[ pixel ] := f.color
                              --}}}
                            pixel := pixel + 1
                            bitmask := bitmask >> 1
                    --}}}
                    pixel := (pixel - (PixWidthBytes<<3)) + pixels.line

                cursor.x := cursor.x + char.spacing
              --}}}
              IF
                delayed.crlf
                  --{{{  we need carriage return - line feed
                  SEQ
                    cursor.x := 0
                    line.feed ()
                  --}}}
                TRUE
                  SKIP
          --}}}
      TRUE
        SKIP
:
--}}}
--{{{  write.string v2.0
PROC write.string ( [] INT window, [] BYTE screen,
                    VAL [] BYTE string, VAL [] INT font )

  [fs.size] INT spec :
  SEQ
    get.font.spec( font, spec )
    SEQ i = 0 FOR (SIZE string)
      draw.char( window, screen, string[i], font, spec )
:
--}}}
--{{{  string.width
PROC string.width ( VAL [] INT font, VAL [] BYTE string, INT width )

  [fs.size] INT spec :
  SEQ
    get.font.spec( font, spec )
    width := 0
    SEQ i = 0 FOR SIZE string
      --{{{  add width for character[i]
      INT character :
      SEQ
        character := INT string[i]
        IF
          (character >= spec[ fs.FirstChar ]) AND (character <= spec[ fs.LastChar]
)
            SEQ
              character := character - spec[ fs.FirstChar ]
```

```
              --{{{  determine width from font
              IF
                spec[ fs.PixWidth ] <> 0                                -- Fixed Width
                  width := width + spec[ fs.PixWidth ]
                TRUE                                                    -- Variable
Width
                  INT char.width.p, char.pointer.p :
                  SEQ
                    char.width.p    := CharTable.p + (character << 2)
                    width := (width + 1) + (INT(GetINT16(char.width.p, font)))
              --}}}
            TRUE
              SKIP
        --}}}
:
--}}}
--}}}
--}}}
```

Video.occ

```
PROC Video ( CHAN OF ANY fromHost, fromAnalog, toAnalog )

  --{{{  libraries
  --#INCLUDE  "s_header.inc"
  #INCLUDE  "\seeker\g_header.inc"
  #INCLUDE  "\seeker\crtc.inc"
  #INCLUDE "common.inc"

  #USE  "convert.lib"
  #USE  "\seeker\graphics.lib"
  --#USE  "extrio.lib"
  --}}}
  --{{{  display constants
  VAL  width          IS       640 :
  VAL  height         IS       480 :
  VAL  line.frequency IS     60000 :
  VAL  frame.rate     IS        90 :
  VAL  pixel.clock    IS  64000000 :
  VAL  interlace      IS     FALSE :
  --}}}
  --{{{  fonts
  #INCLUDE "\seeker\sys6.inc"
  --}}}
  --{{{  place system variables
  [(20*65536)+1280] BYTE screen.map :
  PLACE screen.map AT screen.int.address :

  INT DisplayStart :
  PLACE DisplayStart AT DisplayStart.address :

  INT EventMode :
  PLACE EventMode AT EventMode.address :

  INT SysReady :
  PLACE SysReady AT (#00080000  >< (MOSTNEG INT)) >> 2 :

  INT Ready :
  PLACE Ready AT Ready.address :
  --}}}
  --{{{  set up multiple screens
  VAL screen.offset IS  [ #00000, #50000, #A0000, #F0000 ] :

  VAL screen.address IS [ #00000, #14000, #28000, #3C000 ] :
  --}}}
  --{{{  place Event channel
  CHAN OF ANY Event :
  PLACE Event AT 8 :
  --}}}
  --{{{  constants
  VAL  screen.width   IS  640 :
  VAL  screen.height  IS  480 :
  VAL  screen.size    IS  screen.width * screen.height :

  VAL  char.width     IS   18 :
  VAL  char.height    IS   33 :
  --}}}
  --{{{  procs
  --{{{  libraries
  #INCLUDE "g_header.inc"
  --}}}
  --{{{  IMAX
  INT FUNCTION IMAX ( VAL INT a, b )

    INT r :
```

```
  VALOF
    IF
      a > b
        r := a
      TRUE
        r := b
    RESULT r
:
--}}}
--{{{  IMIN
INT FUNCTION IMIN ( VAL INT a, b )

  INT r :
  VALOF
    IF
      a < b
        r := a
      TRUE
        r := b
    RESULT r
:
--}}}
--{{{  plot
PROC plot ( VAL [] INT window, [] BYTE screen,
            VAL INT x, y, VAL BYTE color )

  -- plots a single point on the screen
  -- makes sure the pixels are actually in the window
  VAL pixels.line  IS window[ w.pixels.line ] :
  VAL size.x       IS window[ w.size.x ] :
  VAL size.y       IS window[ w.size.y ] :
  VAL start.x      IS window[ w.start.x ] :
  VAL start.y      IS window[ w.start.y ] :
  VAL fat.pixels.x IS window[ w.cursor.x ] :
  VAL fat.pixels.y IS window[ w.cursor.y ] :
  VAL mask.mode    IS (window[ w.foreground.color] /\ #0F) :
  VAL pixel.mode   IS ((window[ w.foreground.color] /\ #F0) >> 4) :
  VAL [4]BYTE fg   RETYPES (window[ w.foreground.color]) :
  VAL max.color    IS (INT fg[1]) :
  INT current.color :
  INT screen.position :
  SEQ
    IF
      (x < 0) OR (y < 0) OR (x >= size.x) OR (y >= size.y)
        SKIP
      TRUE
        SEQ
          --{{{  get address and current color
          VAL fat.y IS y TIMES fat.pixels.y :
          VAL fat.x IS x TIMES fat.pixels.x :
          screen.position := (start.x + (start.y TIMES pixels.line)) +
                             ((fat.y TIMES pixels.line) + fat.x)
          current.color := INT screen[screen.position]
          --}}}
          IF
            --{{{  skip under certain conditions
            (mask.mode = MASK) AND (current.color = 0 )
              SKIP
            (mask.mode = UNMASK) AND (current.color <> 0 )
              SKIP
            --}}}
            TRUE
              BYTE temp.color :
              SEQ
                IF
                  pixel.mode = ADD
                    INT i.color :
```

```
                    SEQ
                      i.color := (INT color) + current.color
                      temp.color := BYTE (IMIN (IMAX(i.color, 0), max.color))
                  TRUE
                    temp.color := color
                --{{{  write pixel(s)
                SEQ i = 0 FOR fat.pixels.y
                  SEQ j = 0 FOR fat.pixels.x
                    screen[ (screen.position + j) +
                            (i TIMES pixels.line)] := temp.color
                --}}}
:
--}}}
--{{{  draw.line
PROC draw.line ( VAL [] INT window, [] BYTE screen,
                 VAL INT x1, y1, x2, y2,
                 VAL BYTE color )

  --{{{  clip.line
  PROC clip.line (VAL INT x1, y1, x2, y2, INT result, VAL []INT window)
    -- decides whether a line is totally on or off screen/window
    --{{{  codes
    VAL code.centre IS #00 :        -- 0000
    VAL code.left   IS #01 :        -- 0001
    VAL code.right  IS #02 :        -- 0010
    VAL code.bottom IS #04 :        -- 0100
    VAL code.top    IS #08 :        -- 1000
    --}}}
    INT code1, code2 :
    --{{{  PROC check
    PROC check (VAL INT x, y, INT code)
      VAL x.max IS window[ w.size.x ] :
      VAL y.max IS window[ w.size.y ] :
      SEQ
        IF
          --{{{  x.min <= x < x.max
          (x >= 0) AND (x < x.max)
            code := code.centre
          --}}}
          --{{{  x < x.min
          x < 0
            code := code.left
          --}}}
          --{{{  x > x.max
          TRUE --x >= x.max
            code := code.right
          --}}}
        IF
          --{{{  y.min <= y < y.max
          (y >= 0) AND (y < y.max)
            SKIP
          --}}}
          --{{{  y < y.min
          y < 0
            code := code \/ code.top
          --}}}
          --{{{  y >= y.max
          TRUE --y > y.max
            code := code \/ code.bottom
          --}}}
    :
    --}}}
    SEQ
      check (x1, y1, code1)
      check (x2, y2, code2)
      IF
        --{{{  line lies entirely within window
```

```
        (code1 \/ code2) = 0
          result := in.range
        --}}}
        --{{{  line lies entirely outside window
        (code1 /\ code2) <> 0
          result := not.inrange
        --}}}
        --{{{  partially in window perhaps
        TRUE
          result := part.inrange
        --}}}
:
--}}}
--{{{  slow.draw.line
PROC slow.draw.line ( VAL [] INT window, [] BYTE screen,
                      VAL INT x1, y1, x2, y2,
                      VAL BYTE color )
  -- uses Bresenham's integer algorithm to calculate plotting points
  -- calls plot to draw actual pixels on the screen
  VAL pixels.line IS window[w.pixels.line] :
  INT dx, dy :
  INT two.dx, two.dy :
  INT error :
  SEQ
    dx := x2 - x1
    dy := y2 - y1
    IF
      (dx <> 0) OR (dy <> 0)
        SEQ
          --{{{  a line to draw
          IF
            --{{{  dy = 0                -- horizontal line
            dy = 0
              SEQ i = x1 FOR dx + 1
                plot (window, screen, i, y1, color)
            --}}}
            --{{{  dx = 0                -- vertical line
            dx = 0
              SEQ
                IF
                  dy > 0
                    SEQ i = y1 FOR dy + 1
                      plot (window, screen, x1, i, color)
                  TRUE
                    SEQ i = y2 FOR (-dy) + 1
                      plot (window, screen, x1, i, color)
            --}}}
            --{{{  dx <> 0  dy <> 0     -- diagonal line
            TRUE
              INT x, y :
              INT delta.y :
              SEQ
                x := x1
                y := y1
                two.dx := dx + dx
                IF
                  --{{{  dy > 0
                  dy > 0
                    SEQ
                      two.dy := dy + dy
                      IF
                        --{{{  dy > dx
                        dy > dx
                          SEQ
                            error := two.dx - dy
                            --{{{  plot line
                            SEQ i = 0 FOR dy + 1
```

```
            SEQ
              plot (window, screen, x, y, color )
              IF
                error >= 0
                  SEQ
                    x := x + 1
                    error := error - two.dy
                TRUE
                  SKIP
              y := y + 1
              error := error + two.dx
          --}}}
        --}}}
        --{{{  dy <= dx
        TRUE
          SEQ
            error := two.dy - dx
            --{{{  plot line
            SEQ i = 0 FOR dx + 1
              SEQ
                plot (window, screen, x, y, color )
                IF
                  error >= 0
                    SEQ
                      y := y + 1
                      error := error - two.dx
                  TRUE
                    SKIP
                x := x + 1
                error := error + two.dy
            --}}}
        --}}}
--}}}
--{{{  dy < 0
TRUE
  SEQ
    dy := -dy
    two.dy := dy + dy
    IF
      --{{{  dy > dx
      dy > dx
        SEQ
          error := two.dx - dy
          --{{{  plot line
          SEQ i = 0 FOR dy + 1
            SEQ
              plot (window, screen, x, y, color)
              IF
                error >= 0
                  SEQ
                    x := x + 1
                    error := error - two.dy
                TRUE
                  SKIP
              y := y - 1
              error := error + two.dx
          --}}}
      --}}}
      --{{{  dy <= dx
      TRUE
        SEQ
          error := two.dy - dx
          SEQ i = 0 FOR dx + 1
            SEQ
              plot (window, screen, x, y, color)
              IF
                error >= 0
```

```
                                        SEQ
                                          y := y - 1
                                          error := error - two.dx
                                      TRUE
                                        SKIP
                                    x := x + 1
                                    error := error + two.dy
                              --}}}
                        --}}}
                  --}}}
                --}}}
        TRUE
          plot (window, screen, x1, y1, color)
:
--}}}
--{{{  fast.draw.line
PROC fast.draw.line (VAL [] INT window, [] BYTE screen,
                     VAL INT x1, y1, x2, y2,
                     VAL BYTE  color)

  -- uses Bresenham's integer algorithm to calculate plotting points
  -- points are in increasing values of x
  -- only called when the line is known to be on screen / in window and
  -- the current pixel size is one
  INT dx, dy, two.dx, two.dy, delta.x, delta.y :
  INT error, pixel :
  VAL pixels.line IS window[ w.pixels.line ] :
  SEQ
    dx := x2 - x1               -- always zero or positive
    dy := y2 - y1
    pixel := (y1 * pixels.line) + x1
    IF
      (dx <> 0) OR (dy <> 0)
        SEQ
          --{{{  a line to draw
          IF
            --{{{  dy = 0                -- horizontal line
            dy = 0
              SEQ i = pixel FOR dx + 1
                screen[i] := color
            --}}}
            --{{{  dx = 0                -- vertical line
            dx = 0
              SEQ
                IF
                  dy > 0
                    SEQ i = 0 FOR dy + 1
                      SEQ
                        screen[pixel] := color
                        pixel := pixel + pixels.line
                  TRUE
                    SEQ i = 0 FOR (-dy) + 1
                      SEQ
                        screen[pixel] := color
                        pixel := pixel - pixels.line
            --}}}
            --{{{  dx <> 0 AND dy <> 0
            TRUE
              INT delta.y :
              SEQ
                two.dx := dx + dx
                IF
                  dy > 0
                    delta.y := pixels.line
                  TRUE
                    SEQ
                      dy := -dy
```

```
                delta.y := -pixels.line
              two.dy := dy + dy
              IF
                --{{{  dy > dx
                dy > dx
                  SEQ
                    error := two.dx - dy
                    --{{{  plot line
                    SEQ i = 0 FOR dy + 1
                      SEQ
                        screen[pixel] := color
                        IF
                          error >= 0
                            SEQ
                              pixel := pixel + 1
                              error := error - two.dy
                          TRUE
                            SKIP
                        pixel := pixel + delta.y
                        error := error + two.dx
                    --}}}
                --}}}
                --{{{  dy <= dx
                TRUE
                  SEQ
                    error := two.dy - dx
                    --{{{  plot line
                    SEQ i = 0 FOR dx + 1
                      SEQ
                        screen[pixel] := color
                        IF
                          error >= 0
                            SEQ
                              pixel := pixel + delta.y
                              error := error - two.dx
                          TRUE
                            SKIP
                        pixel := pixel + 1
                        error := error + two.dy
                    --}}}
                --}}}
            --}}}
          --}}}
      TRUE
        screen[pixel] := color
:
--}}}
INT x3, y3, x4, y4 :
INT result :
SEQ
  --{{{  swap x1,y1 with x2,y2 if x1 > x2
  IF
    x1 > x2
      SEQ
        x3 := x2
        y3 := y2
        x4 := x1
        y4 := y1
    TRUE
      SEQ
        x3 := x1
        y3 := y1
        x4 := x2
        y4 := y2
  --}}}
  clip.line (x3, y3, x4, y4, result, window)
  IF
```

```
      (result = in.range)
        --fast.draw.line (window, screen, x3, y3, x4, y4, color)
        slow.draw.line (window, screen, x3, y3, x4, y4, color)
      (result = part.inrange) OR (result = in.range)
        slow.draw.line (window, screen, x3, y3, x4, y4, color)
      TRUE
        SKIP
:
--}}}
--{{{  draw.polyline
PROC draw.polyline ( VAL [] INT window, [] BYTE screen,
                     VAL [][2]INT points, VAL BYTE color)

  -- calls draw line to draw the lines
  INT x, y :
  SEQ
    x := points[0][0]
    y := points[0][1]
    SEQ i = 1 FOR (SIZE points) - 1
      VAL point IS points[i] :
      SEQ
        draw.line( window, screen, x, y, point[0], point[1], color )
        x := point[0]
        y := point[1]
:
--}}}
--{{{  draw.rectangle
PROC draw.rectangle ( VAL [] INT window, [] BYTE screen,
                      VAL [2][2]INT p, VAL BYTE color)

  -- calls draw line to draw the lines
  INT x, y :
  SEQ
    draw.line( window, screen, p[0][0], p[0][1], p[1][0], p[0][1], color )
    draw.line( window, screen, p[1][0], p[0][1], p[1][0], p[1][1], color )
    draw.line( window, screen, p[1][0], p[1][1], p[0][0], p[1][1], color )
    draw.line( window, screen, p[0][0], p[1][1], p[0][0], p[0][0], color )
:
--}}}
--{{{  spectrum
PROC spectrum ( CHAN OF ANY out )

  SEQ
    SEQ i = 0 FOR 64                          -- blue to red scale for 1 to 63
      set.colour( out, 0, i, i, 0, 31-(i>>1) )
    SEQ i = 0 FOR 64                          -- adding green and blue
      set.colour( out, 0, 64+i, 63, i, i )    --    for 64 to 127

    SEQ i = 128 FOR 128                       -- green for 128-255
      set.colour( out, 0, i, 0, 63, 0 )
    set.colour( out, 0, 0, 0, 0, 0 )          -- black for 0
    set.colour( out, 0, 128, 30, 30, 30 )     -- grey for 128
:
--}}}
--{{{  center.string
PROC center.string ( [] INT window, [] BYTE screen,
                     VAL INT cx, sy, VAL [] BYTE string,
                     VAL [] INT font )

  INT width :
  SEQ
    string.width( font, string, width )
    window[ w.cursor.y ] := sy
    window[ w.cursor.x ] := cx - (width >> 1)
    write.string( window, screen, string, font )
:
--}}}
```

```
--{{{  place.string
PROC place.string ( [] INT window, [] BYTE screen,
                    VAL INT sx, sy, VAL [] BYTE string,
                    VAL [] INT font )

  SEQ
    window[ w.cursor.y ] := sy
    window[ w.cursor.x ] := sx
    write.string( window, screen, string, font )
:
--}}}
--{{{  EventProc
PROC EventProc ( CHAN OF ANY Event, in )

  INT synch, address :
  WHILE TRUE
    SEQ
      in ? address
      Ready := 1
      Event ? synch
      DisplayStart := address
      Ready := 0
:
--}}}
--{{{  Buffer
PROC Buffer ( CHAN OF ANY in, out )

  INT temp :
  SEQ
    WHILE TRUE
      SEQ
        in ? temp
        out ! temp
:
--}}}
--{{{  set.text.window
PROC set.text.window ( [] INT window,
                       VAL [] BYTE string1, string2, VAL [] INT font,
                       VAL INT start.x, start.y, size.y )

  SEQ
    string.width( font, string1, window[ w.start.x ] )
    string.width( font, string2, window[ w.size.x ] )
    window[ w.start.x ] := window[ w.start.x ] + start.x
    window[ w.size.x  ] := window[ w.size.x  ] + 1
    window[ w.start.y ] := start.y
    window[ w.size.y  ] := size.y + 1
    window[ w.start ] := (screen.width * start.y) + window[ w.start.x ]
    window[ w.size  ] := screen.width * window[ w.size.y ]
    window[ w.pixels.line ] := screen.width
    window[ w.foreground.color ] := 255
    window[ w.background.color ] := 0
    window[ w.cursor.x ] := 0
    window[ w.cursor.y ] := 0
:
--}}}
--{{{  display.text
PROC display.text ( [] INT window, [] BYTE screen,
                    VAL [] BYTE text, VAL [] INT font )

  s IS [screen FROM window[ w.start ] FOR window[ w.size ]] :
  SEQ
    window[ w.cursor.x ] := 0
    window[ w.cursor.y ] := 0
    write.string( window, s, text, font )
:
--}}}
```

```
--{{{  place.numbers
PROC place.numbers ( [][] BYTE screen, [][][] BYTE char.array,
                     VAL [] BYTE string,
                     VAL INT start.x, start.y, size.x, size.y )

  INT x :
  SEQ
    x := start.x
    SEQ i = 0 FOR SIZE string
      VAL char IS INT string[i] :
      SEQ
        IF
          --{{{  display space character
          char = (INT ' ')
            VAL source IS char.array[11] :
            MOVE2D( source, 0, 0, screen, x, start.y, size.x, size.y )
          --}}}
          --{{{  display decimal character
          char = (INT '.')
            VAL source IS char.array[10] :
            MOVE2D( source, 0, 0, screen, x, start.y, size.x, size.y )
          --}}}
          --{{{  display number character
          TRUE
            VAL source IS char.array[char - (INT '0')] :
            MOVE2D( source, 0, 0, screen, x, start.y, size.x, size.y )
          --}}}
        x := x + size.x
:
--}}}
--{{{  MAX
REAL32 FUNCTION MAX ( VAL REAL32 a, b )

  REAL32 r :
  VALOF
    IF
      a > b
        r := a
      TRUE
        r := b
    RESULT r
:
--}}}
--{{{  MIN
REAL32 FUNCTION MIN ( VAL REAL32 a, b )

  REAL32 r :
  VALOF
    IF
      a < b
        r := a
      TRUE
        r := b
    RESULT r
:
--}}}
--}}}
--{{{  variables
[w.length] INT window :
[4][w.length] INT text.window :
[12][char.height][char.width] BYTE number :

INT pixel.mode :
INT mask.mode :

CHAN OF ANY synch, synch1 :
--}}}
```

```
VAL font IS SYS6 :
SEQ
  --{{{  initialize
  set.B408( 0, 0, 0, 0, 0 )
  --{{{  set up B409
  set.timing( toAnalog, width, height, line.frequency,
              frame.rate, pixel.clock, interlace )
  spectrum( toAnalog )
  --}}}
  --{{{  generate display table for nu' 'rs
  [w.length] INT window :
  [12][char.width*char.height] BYTE n RETYPES number :
  SEQ
    SEQ i = 0 FOR 12
      SEQ j = 0 FOR char.width*char.height
        n[i][j] := 0 (BYTE)
    window := [ 0, char.width*char.height, char.width,
                0, 0, char.width, char.height, 255, 0, 0, 0 ]
    SEQ i = 0 FOR 10
      display.text( window, n[i], [ BYTE( i+(INT '0') )], font )
    display.text( window, n[10], ".", font )
    display.text( window, n[11], " ", font )
  --}}}
  --{{{  initial display
  [] INT int.screen RETYPES screen.map :
  SEQ i = 0 FOR (20*65536)/4
    int.screen[i] := 0

  window := [ 0, screen.size, screen.width, 0, 0,
              screen.width, screen.height, 255, 0, 1, 1 ]
  screen IS [screen.map FROM screen.offset[0] FOR screen.size] :
  SEQ
    --{{{  draw first box
    draw.line( window, screen,  31, 111, 288, 111, 255(BYTE) )
    draw.line( window, screen, 288, 111, 288, 368, 255(BYTE) )
    draw.line( window, screen,  31, 368, 288, 368, 255(BYTE) )
    draw.line( window, screen,  31, 111,  31, 368, 255(BYTE) )
    --}}}
    --{{{  draw second box
    draw.line( window, screen, 351, 111, 608, 111, 255(BYTE) )
    draw.line( window, screen, 608, 111, 608, 368, 255(BYTE) )
    draw.line( window, screen, 351, 368, 608, 368, 255(BYTE) )
    draw.line( window, screen, 351, 111, 351, 368, 255(BYTE) )
    --}}}
    --{{{  draw text
    SEQ
      center.string( window, screen, 320, 1, "FPA Seeker Emulator", font )
      center.string( window, screen, 160, 70, "Raw FPA Image", font )
      center.string( window, screen, 480, 70, "Processed Image", font )

      --place.string( window, screen, 0, 400, "Range: ", font )
      --place.string( window, screen, 0, 440, "Sim Time: ", font )
      --place.string( window, screen, 350, 400, "Frame Rate:", font )
      --place.string( window, screen, 350, 440, "Frame Number:", font )

      --set.text.window( text.window[0], "Range:", "0123456.789", font,  16,400,
32 )
      --set.text.window( text.window[1], "Sim Time: ", "123.456", font,  16,440,
32 )
      --set.text.window( text.window[2], "Frame Rate:   ", "123", font, 350,400,
32 )
      --set.text.window( text.window[3], "Frame Number: ", "123", font, 350,440,
32 )
    --}}}

    window := [0, screen.size, screen.width, 32, 112, 128, 128,
               0, 0, 2, 2 ]
```

```
    --[screen.map FROM screen.offset[1] FOR screen.size] := screen
    --[screen.map FROM screen.offset[2] FOR screen.size] := screen
    --[screen.map FROM screen.offset[3] FOR screen.size] := screen
  --}}}
  set.B408( 0, 0, 0, 1, 0 )
  --}}}
  --{{{  run
  screen IS [screen.map FROM screen.offset[0] FOR screen.size ] :
  [max.command.line]INT command.line :
  INT length :
  INT color.shift :
  WHILE TRUE
    SEQ
      --{{{  initialize
      color.shift := 1
      --}}}
      fromHost ? length::command.line

      CASE command.line[0]
        --{{{  plot point
        c.plot
          x      IS command.line[1] :
          y      IS command.line[2] :
          VAL color  IS (command.line[3] >> color.shift):
          plot (window, screen, x, y, (BYTE color))
        --}}}
        --{{{  line
        c.line
          x1      IS command.line[1] :
          y1      IS command.line[2] :
          x2      IS command.line[3] :
          y2      IS command.line[4] :
          VAL color   IS (command.line[5] >> color.shift):
          draw.line (window, screen, x1, y1, x2, y2, (BYTE color))
        --}}}
        --{{{  clear
        --}}}
        --{{{  mask.mode
        c.mask.mode
          INT temp :
          SEQ
            mask.mode := command.line[1]
            temp := window[w.foreground.color]
            temp := temp /\ #F0  -- mask off 4 bits
            temp := temp \/ mask.mode
            window[w.foreground.color] := temp
        --}}}
        --{{{  pixel.mode
        c.pixel.mode
          INT temp :
          SEQ
            pixel.mode := command.line[1]
            temp := window[w.foreground.color]
            temp := temp /\ #0F  -- mask off 4 bits
            temp := temp \/ (pixel.mode << 4)
            window[w.foreground.color] := temp
        --}}}
  --}}}
:
```